

A PROJECT MANUAL FOR

REPAIR DINING FACILITY, BLDG 668

**MAXWELL AIR FORCE BASE
MONTGOMERY, ALABAMA**

PROJECT NUMBER PNQS 09 – 4491
PHJA/2223US

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LIST OF ABBREVIATIONS

REFERENCED STANDARDS AND AGENCIES

AA	ALUMINUM ASSOCIATION	IBC	INTERNATIONAL BUILDING CODE
AASHTO	AMERICAN ASSOCIATION STATE HIGHWAY & TRANSPORTATION OFFICIALS	ICC	INTERNATIONAL CODE COUNCIL
AABC	ASSOCIATED AIR BALANCE COUNCIL	IECC	INTERNATIONAL ELECTRICAL CODE COUNCIL
ABC	ALABAMA BUILDING COMMISSION	IFC	INTERNATIONAL FIRE CODE
ACI	AMERICAN CONCRETE INSTITUTE	IFGC	INTERNATIONAL FUEL GAS CODE
ACIL	AMERICAN COUNCIL OF INDEPENDENT LABORATORIES	IES	ILLUMINATING ENGINEERING SOCIETY
ACPA	AMERICAN CONCRETE PIPE ASSOCIATION	ILA	INDIANA LIMESTONE INSTITUTE
ACRMA	AIR CONDITIONING AND REFRIG.MACHINERY ASSOC.	MBMA	METAL BUILDING MANUFACTURERS ASSOC.
ADC	AIR DIFFUSION COUNCIL	MBSA	MODULAR BUILDING STANDARDS ASSOCIATION
ADEM	ALABAMA DEPARTMENT OF ENVIRONMENTAL MANAGEMENT	MFMA	MARBLE FLOORING MANUFACTURERS ASSOCIATION
AGA	AMERICAN GAS ASSOCIATION	MIA	MARBLE INSTITUTE OF AMERICA
AGC	ASSOC. GEN. CONTRACTORS OF AMER.; ALABAMA GAS CORP.	MLMA	MARBLE LATHE MANUFACTURERS ASSOCIATION
AHA	AMERICAN HARDBOARD ASSOCIATION	MWI	METAL WINDOW INSTITUTE
AHD	ALABAMA HIGHWAY DEPARTMENT	NAAMM	NATIONAL ASSOC. ARCHITECTURAL METAL MANUF.
AIA	ALABAMA INSTITUTE OF ARCHITECTS	NBLP	NATIONAL BUREAU OF LATHING AND PLASTERING
AIA	AMERICAN INSURANCE ASSOCIATION	NACA	NATIONAL ACOUSTICAL CONTRACTORS ASSOCIATION
AIA	ASBESTOS INFORMATION ASSOCIATION	NAEC	NATIONAL ASSOCIATION OF ELEVATOR CONTRACTORS
AISC	AMERICAN INSTITUTE OF STEEL CONSTRUCTION	NASFC	NATIONAL AUTOMATIC SPRINKLER AND FIRE CONTROL
AISI	AMERICAN IRON AND STEEL INSTITUTE	NBS	NATIONAL BUREAU OF STANDARDS
AITC	AMERICAN INSTITUTE OF TIMBER CONSTRUCTION	NCHA	NATIONAL CONTRACT HARDWARE ASSOCIATION
ALDOT	ALABAMA DEPARTMENT OF TRANSPORTATION	NCMA	NATIONAL CONCRETE MASONRY ASSOCIATION
AMMA	AMERICAN METAL MANUFACTURERS ASSOCIATION	NEC	NATIONAL ELECTRICAL CODE
ANSI	AMERICAN NATIONAL STANDARDS INSTITUTE	NEMA	NATIONAL ELECTRICAL MANUFACTURERS ASSOC.
APA	AMERICAN PLYWOOD ASSOCIATION	NFPA	NATIONAL FIRE PROTECTION ASSOCIATION
APC	ALABAMA POWER COMPANY	NIOHS	NATIONAL INST.OF OCCUPATIONALHEALTH & SAFETY
ARI	AIR CONDITIONERS AND REFRIGERATION INSTITUTE	NLI	NATIONAL LIMESTONE INSTITUTE
ASA	AMERICAN STANDARDS ASSOCIATION	NLMA	NATIONAL LUMBER MANUFACTURERS ASSOCIATION
ASHRAE	AMER. SOC. HEATING, REFRIG. & AC ENGINEERS	NOFMA	NATIONAL OAK FLOOR MANUFACTURING ASSOCIATION
ASLA	AMERICAN SOCIETY OF LANDSCAPE ARCHITECTS	NPCA	NATIONAL PRECAST CONCRETE ASSOCIATION
ASME	AMERICAN SOCIETY OF MECHANICAL ENGINEERS	NSF	NATIONAL SANITATION FOUNDATION
ASTM	AMERICAN SOCIETY FOR TESTING & MATERIALS	NTMA	NATIONAL TERRAZZO AND MOSAIC ASSOCIATION
AT&T	AMERICAN TELEPHONE & TELEGRAPH COMPANY	OSHA	OCCUPATIONAL SAFETY AND HEALTH ADMIN.
AWCI	ASSOCIATION OF WALL AND CEILING INDUSTRIES	PATMI	POWER ACTUATED TOOL MANUFACTURERS INSTITUTE
AWI	ARCHITECTURAL WOODWORK INSTITUTE	PCA	PORTLAND CEMENT ASSOCIATION
AWMA	ALUMINUM WINDOW MANUFACTURERS ASSOCIATION	PCI	PRESTRESSED CONCRETE INSTITUTE
AWPA	AMERICAN WOOD PROTECTION ASSOCIATION	PDI	PLUMBING AND DRAINAGE INSTITUTE
AWWA	AMERICAN WATER WORKS ASSOCIATION	PEI	PORCELAIN ENAMEL INSTITUTE
AWS	AMERICAN WELDING SOCIETY	PI	PERLITE INSTITUTE
BIA	BRICK INSTITUTE OF AMERICA	PSC	PUBLIC SERVICE COMMISSION
BHMA	BUILDERS HARDWARE MANUFACTURERS ASSOCIATION	SAA	SURETY ASSOCIATION OF AMERICA
CABRA	COPPER AND BRASS RESEARCH ASSOCIATION	SBI	STEEL BOILER INSTITUTE
CLFMI	CHAIN LINK FENCE MANUFACTURING INSTITUTE	SBTMA	SOUTHERN BRICK AND TILE MANUFACTURERS ASSOC.
CPA	CONSUMER PROTECTION AGENCY	SCB	SOUTH CENTRAL BELL
CPSC	CONSUMER PROTECTION SAFETY COMMISSION	SCPI	STRUCTURAL CLAY PRODUCTS INSTITUTE
CRA	CALIFORNIA REDWOOD ASSOCIATION	SDI	STEEL DOOR INSTITUTE; STEEL DECK INSTITUTE
CRSI	CONCRETE REINFORCING STEEL INSTITUTE	SIGMA	SEALED INSULATING GLASS MANUFACTURERS ASSOC.
CS	COMMERCIAL STANDARD	SJI	STEEL JOIST INSTITUTE
CSI	CONSTRUCTION SPECIFICATIONS INSTITUTE	SMACCA	SHEET METAL & AIR COND.CONTRACTORS ASSOC.
DFPA	DOUGLAS FIR PLYWOOD ASSOCIATION	SPA	SOUTHERN PINE ASSOCIATION
DHI	DOOR & HARDWARE INSTITUTE	SPIB	SOUTHERN PINE INSPECTION BUREAU
EPA	ENVIRONMENTAL PROTECTION AGENCY	SPR	SIMPLIFIED PRACTICE RECOMMENDATIONS
EIA	ELECTRONICS INDUSTRIES ASSOCIATION	SPC	STRUCTURES PAINTING COUNCIL
FHA	FEDERAL HOUSING ADMINISTRATION	SRI	STEEL RECYCLING INSTITUTE
FM	FACTORY MUTUAL LABORATORIES	SSPC	SOCIETY FOR PROTECTIVE COATING
FS	FEDERAL SPECIFICATION	SWI	STEEL WINDOW INSTITUTE
FGJA	FLAT GLASS JOBBERS ASSOCIATION	TAIA	THE AMERICAN INSURANCE ASSOCIATION
FTI	FACING TILE INSTITUTE	TCNA	TILE COUNCIL OF NORTH AMERICA
GRDF	GYPSON ROOF DECK FOUNDATION	TMA	TILE MANUFACTURERS ASSOCIATION
GSA	GENERAL SERVICES ASSOCIATION	UL	UNDERWRITERS LABORATORIES
		USDA	U.S. DEPARTMENT OF AGRICULTURE
		VI	VERMICULITE INSTITUTION
		VWPI	VACCUM WOOD PRESERVATIVE INSTITUTE
		WCLIB	WEST COAST LUMBER INSPECTION BUREAU
		WRI	WIRE REINFORCEMENT INSTITUTE

MISCELLANEOUS REFERENCES

A	AMPERES; AREA; ARCHITECTURAL	DR	DRAWER; DRAIN; DOOR; DINING ROOM
AB	ANCHOR BOLT	DS	DOWNSPOUT
ABD	ACOUSTICAL BOARD	DW	DISHWASHER
AC	ALTERNATING CURRENT; AIR CONDITIONING	DWG	DRAWING
ACOU	ACOUSTICAL		
ACT	ACTIVE	E	EAST; ELECTRICAL; ENTRY
AD	AREA DRAIN	EA	EACH
ADJ	ADJUSTABLE	EB	EXPANSION BOLT
AFF	ABOVE FINISH FLOOR	EDF	ELEC DRINKING FOUNTAIN
AHU	AIR HANDLING UNIT	EJF	EXPANSION JOINT FILLER
AL	ALUMINUM	EL	ELEVATION
ALT	ALTERNATE	ELEC	ELECTRIC
ALUM	ALUMINUM	ELEV	ELEVATOR; ELEVATION
ASPH	ASPHALT	ELD	ELECTRIC LOCKING DEVICE
AT	ACOUSTICAL TILE	ENT	ENTRANCE
AUTO	AUTOMATIC	EOS	END OF SECTION
AVE	AVENUE	EQ	EQUAL; EQUIPMENT
AVG	AVERAGE	EQUIP	EQUIPMENT
AWG	AMERICAN WIRE GAUGE	EW	EACH WAY
		EWC	ELECTRIC WATER COOLER
B	BATH	EXB	EXPANSION BOLT
BC	BACK CHECK	EXH	EXHAUST
BD	BOARD	EXIST	EXISTING
BEJ	BUILDING EXPANSION JOINT	EXP	EXPANSION
BET	BETWEEN	EXP.JT	EXPANSION JOINT
B4E	BEVELED 4 EDGES	EXT	EXTERIOR
BKBD	BACKBOARD	EXTN	EXTENSION
BL	BUILDING LINE		
BLDG	BUILDING	F	FAHRENHEIT; FACE
BM	BENCH MARK; BEAM	FBP	FIRE BARRIER PARTITION
BRDG	BRIDGING	FC	FOOT CANDLE
BS	BOTH SIDES	FD	FLOOR DRAIN; FIRE DAMPER
B&S	BROWN & SHARP	FE	FIRE EXTINGUISHER
BT	BULB TEE	FEC	FIRE EXTINGUISHER CABINET
BTB	BACK-TO-BACK	FED	FEDERAL
BTU	BRITISH THERMAL UNIT	FF	FINISH FLOOR
BU	BUILT UP	FH	FIRE HYDRANT; FLAT HEAD
		FHC	FIRE HOSE; CABINET
C	CARPET; CONDUIT; COURSE; CENTIGRADE; CIVIL;	FL	FLOW LINE; FLOOR LINE; FLOOR; FUSIBLE LINK
	CORRIDOR	FOW	FACE OF WALL
CAB	CABINET	FPM	FEET PER MINUTE
CAT	CATALOG	FR	FIRE RATED
CB	CHALKBOARD; CONCRETE BLOCK	FS	FULL SIZE; FEDERAL SPEC
CC	CUBIC CENTIMETER	FT	FOOT
CDC	CLOSE DON'T COUNT	FTF	FACE TO FACE
CEM	CEMENT	FVC	FOOTING
CFM	CUBIC FEET PER MINUTE	FVC	FIRE VALVE CABINET
CG	CORNER GUARD	FYC	FOR YOUR CONSIDERATION
CI	CAST IRON	FYI	FOR YOUR INFORMATION
CJ	CONSTRUCTION JOINT		
CL	CENTER LINE	G	GAS
C&G	CURB & GUTTER	GA	GAUGE
CLG	CEILING	GAL	GALLON
CM	CONSTRUCTION MGR; CORRUGATED METAL	GALV	GALVANIZED
CMU	CONCRETE MASONRY UNIT	GB	GRAB BAR; GYPSUM BOARD
CO	CLEAN OUT; CHANGE ORDER	GBR	GUINNESS BOOK OF RECORDS
COND	CONDENSATE	GC	GENERAL CONTRACTOR; GENERAL CONDITONS
COL	COLUMN	GG	GRAVEL GUARD
CONC	CONCRETE	GI	GALVANIZED IRON
CONN	CONNECT	GL	GLASS
CONT	CONTINUOUS	GLM	GOOD LUCK MEN
COR	CORRIDOR	GND	GROUND
CR	COLD ROLLED; CORROSION RESISTANT	GOVT	GOVERNMENT
CRS	CORROSION RESIS STEEL	GP	GALLONS PER SQAURE FOOT
CRT	CATHODE RAY TUBE	GPM	GALLONS PER MINUTE
CSK	COUNTERSUNK	GPY	GALLONS PER SQUARE YARD
CST	CENTRAL STAN TIME	GR	GRADE
CSV	CRAWL SPACE VENT	GT	GLAZED CERAMIC TILE
CT	CERAMIC TILE; EAST THRESHOLD	GV	GATE VALVE
CTC	CENTER TO CENTER	GYP	GYPSUM
CTR	COUNTER		
CW	COLD WATER	H	HEATING (HVAC); HALL
CWR	COLD WATER RETURN	HAC	HEATING/AIR CONDITIONING
CWS	COLD WATER SUPPLY	HB	HOUSE BIBB
CYL	CYLINDER	HC	HOLLOW CORE; HANDICAPPED
		H/C	HANDICAPPED
		HD	HEAVY DUTY
D	PENNY (NAILS, ETC)		
DA	DOUBLE ACTING	HDF	HANDICAP DRINKING FOUNTAIN
DBL	DOUBLE	HFS	HALF FULL SIZE
DET	DETAIL	HG	HEAVY GAUGE
DF	DRINKING FOUNTAIN	HL	HIGH LIMIT
DIA	DIAMETER	HM	HOLLOW METAL
DIAG	DIAGONAL DIAGRAM	HMR	HORIZONTAL MASONRY REINFORCE
DIM	DIMENSION	HO	HOLD OPEN
DO	DITTO	HORIZ	HORIZONTAL
DOZ	DOZEN	HP	HORSEPOWER; HIGH PRESSURE
DN	DOWN	HPL	HIGH PRESSURE LIMIT
DP	DAMPPROOF		

A & E DESIGN – REPAIR DINING FACILITY, BLDG 668
MAXWELL AFB, ALABAMA

MAFB-PNQS-09-4491
PHJA/2223US

HR	HANDRAIL; HOUR	OPN	OPENING
HT	HEIGHT	OPP	OPPOSITE
HW	HOT WATER; HARDWARE (SET)	OSF	OUTSIDE FACE
HWD	HARDWARE	OTO	OUT TO OUT
HVAC	HEATING; VENTILATING, & AC	OXY	OXYGEN
HZ	HERTZ	OZ	OUNCE
ID	INSIDE DIAMETER	P	PLUMBING
INCL	INCLUDE	PA	PARALLEL ARM; PUBLIC ADDRESS
INSUL	INSULATING MATERIAL	PAR	PARAGRAPH
INT	INTERIOR	PAS	POWDER ACTUATED STUD
INV	INVERT	PB	PROJECT BOOK
IPS	IRON PIPE SIZE	P/C	PRESTRESSED CONCRETE; PRECAST CONCRETE
ISF	INSIDE FACE	PCF	POUNDS PER CUBIC FOOT
ITC	IN THIS CONTRACT	PCY	POUNDS PER CUBIC YARD
J	JANITOR	PDF	POWER DRIVEN FASTENER
JAN	JANITOR	PGL	PLATE GLASS
JB	JUNCTION BOX	PH	PHILLIPS HEAD
JR	JUNIOR	PL	PROPERTY LINE; PLATE
JS	JANITOR SINK	PLB	PLUMBING
JSV	JOINT SPACE VENT	PLF	POUNDS PER LINEAR FOOT
JT	JOINT	PLYW	PLYWOOD
K	KIP (1000 LB); KITCHEN	POL	POLISH
KA	KEY ALIKE	PP	POWER POLE
KD	KNOCK DOWN; KEY DIFFERENT	PPS	POUNDS PER SQUARE
KG	KILOGRAM	PRV	PRESSURE REDUCING VALVE
KM	KILOMETER	PSF	POUNDS PER SQUARE FOOT
KV	KILOVOLT	PSI	POUNDS PER SQUARE INCH
KVA	KILOVOLT AMPS	PSIG	POUNDS PER SQUARE INCH GAGE
KW	KILOWATT	PSY	POUNDS PER SQUARE YARD
L	ANGLE (METAL SHAPE)	PT	PRESSURE TREATED
LAM	LAMINATE	PTD	PAPER TOWEL DISPENSER
LAV	LAVATORY	PTP	PLASTIC(FACED)TP
LBS	POUNDS	PVC	POLYVINYL CHLORIDE
LDW	LESS DOOR WIDTH	QT	QUARRY TILE
LED	LIGHT EMITTING DIODE	R	RADIUS; RUBBER
LG	LIGHT GAUGE	RA	RETURN AIR
LH	LEFT HAND	RCP	REFLECTED CEILING PLAN
LIN	LINEAR	RD	ROOF DRAIN; ROAD; ROUND
LL	LOW LIMIT	RE	REFERENCE
LLH	LONG LEG HORIZONTAL	REF	REFRIGERATOR
LLV	LONG LEG VERTICAL	REG	REGISTER
LOC	LOCATION	REV	REVISED
LP	LOW PRESSURE; LIQUID; PETROLEUM; LIGHT PROOF	REQD	REQUIRED
LPL	LAMINATED PLASTIC	RH	RELATIVE HUMIDITY; RIGHTHAND; ROUND HEAD;
LPT	LOCAL PREVAILING TIME		ROBE HOOK
LSG	LAMINATED SAFETY GLASS	RM	ROOM
LT	LIGHT	RO	ROUGH OPENING
LVR	LOUVER	ROW	RIGHT OF WAY
M	MEN	R/W	RIGHT OF WAY
MAX	MAXIMUM	RPM	REVOLUTIONS PER MINUTE
MBT	MARBLE THRESHOLD	RS&S	ROD STOCK & SEALANT
MC	MEDICINE CABINET	RT	RESILIENT TILE
MDO	MEDIUM DENSITY OVERLAY	S	SOUTH; STAIR; STRUCTURAL
MDS	METAL DIVIDER STRIP	SA	SUPPLY AIR SINGLE ACTING
MECH	MECHANICAL	SAN	SANITARY
MED	MEDIUM; MEDICAL	SBP	SMOKE BARRIER PARTITION
MEMB	MEMBER	SC	SOLID CORE; SCALE
MET	METAL	SCH	SCHEDULE
MFG	MANUFACTURER	SCHED	SCHEDULED
MH	MANHOLE	SD	SOAP DISPENSER OR DISH; SMOKE DAMPER
MI	MALLEABLE IRON	SEC	SECTION
MM	MINIMUM; MINUTE	SF	SQUARE FEET
MISC	MISCELLANEOUS	SG	SOAP GRAB
MK	MASTER KEY; MARK	SGT	STRUCTURAL GLAZED TILE
MO	MASONRY OPENING	SH	SHEET
MP	MEDIUM PRESSURE	SHF	SHELF
MPH	MILES PER HOUR	SHVS	SHELVES
MT	METAL THRESHOLD	SI	SQUARE INCH
MTD	MOUNTED	SIM	SIMILAR
MTP	METAL TOILET PARTITION	SLA	SINGLE LEVER ARM
N	NORTH	SNB	SEX NUTS & BOLTS
NA	NOT APPLICABLE	SND	SANITARY NAPKIN DISPENSER
NIC	NOT IN CONTRACT	SOT	SEE OTHER TRADES
NL	NIGHT LATCH	SP	SINGLE PHASE; SINGLE POLE
NO	NUMBER; NITROUS OXIDE	SPEC	SPECIFICATION
NRP	NON-REMOVABLE PIN	SP	SPLASH PAN
NTR	NO TEMPERATURE RATING	SQ	SQUARE
NTS	NOT TO SCALE	SR	SHOWER ROD
OA	OUTSIDE AIR	SS	STAINLESS STEEL; SANITARY SEWER
OC	ON CENTER	SSD	SUB-SURFACE DRAIN
OCEW	ON CENTER EACH WAY	SSMH	SANITARY SEWER MANHOLE
OLF	OUNCE PER LINEAR FOOT	STL	STEEL
OD	OUTSIDE DIAMETER	STR	STRUCTURAL
OH	OVERHEAD; OVAL HEAD	SW	SWITCH
OPG	OPENING	SY	SQUARE YARD
OPH	OPPOSITE HAND	SYP	SOUTHERN YELLOW PINE
		S4S	SURFACE 4 SIDES
		T	TOILET

A & E DESIGN – REPAIR DINING FACILITY, BLDG 668
MAXWELL AFB, ALABAMA

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TAB	TEST & AIR BALANCE
TB	TACKBOARD
T&B	TOP & BOTTOM
TC	TERRA COTTA
TEL	TELEPHONE
TGL	TEMPERED GLASS
TLC	TENDER LOVING CARE
TOC	TOP OF CURB
TOW	TOP OF WALL
TP	TOILET PARTITION
TPH	TOILET PAPER HOLDER
TR	TOWEL ROD
TRANS	TRANSFORMER
TS	TERRAZZO STRIP
TS	TUBE (STRUCTURAL SHAPE) TERRAZZO (EXPANSION) STRIP
TSTAT	THERMOSTAT
TV	TELEVISION
TYP	TYPICAL
U	URINAL
UC	UNERCUT; UNDERCOUNTER
UOS	UNLESS OTHERWISE SHOWN
USG	UNITED STATE GAGE
V	VOLTAGE; VESTIBULE
VAC	VACUUM
VB	VAPOR BARRIER
VC	VITROUS CLAY
VCT	VINYL COMPOSITION TILE
VIB	VIBRATOR
VDT	VIDEO DISPLAY TERMINAL
VP	VAPORPROOF
VAT	VINYL ASBESTOS TILE
W	WOMEN; WATT; WEST
W/	WITH
WC	WATER CLOSET
WD	WINDOW DIMENSION; WOOD
WDW	WINDOW
WF	WIDE FLANGE(BEAM)
WG	WIRE GLASS
WH	WEEP HOLE; WATER HEATER, WALL HYDRANT
WM	WASHING MACHINE
WOT	WORK OF OTHER TRADES
WP	WATER/WEATEHER PROOF
WR	WATER RESISTANT
WS	WOOD SCREWS
W&V	WASTE AND VENT
WWF	WOVEN WIRE FABRIC
WWM	WOVEN WIRE MESH
YH	YARD HYDRANT

*WHERE AN ABBREVIATION HAS MORE THAN ONE MEANING, ASSUME
THE USE APPROPRIATE TO THE TRADE OR ITEM REFERRED TO.

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31 31 16.19	08/22	TERMITE CONTROL BARRIERS

DIVISION 32 - EXTERIOR IMPROVEMENTS

32 16 19	05/18	CONCRETE CURBS, GUTTERS AND SIDEWALKS
32 31 13	11/21	CHAIN LINK FENCES AND GATES
32 92 23	04/06, CHG 1: 08/21	SODDING

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SECTION 00005

SCHEDULE OF BID ITEMS

Furnish all plant, labor, materials and equipment necessary to perform all work in connection with Project Number PNQS 09-4491 Repair Dining Facility, Bldg 668 at Maxwell AFB, Alabama, in accordance with the attached specifications and drawings.

Item No.	Description	Unit of Issue	Unit Price	Total Amount
0001	Repair Dining Facility, Building 668	EA	N/A	\$
0002	Food Service Equipment	EA	N/A	\$

Total Bid Item 0001-0002 \$ _____

Company: _____

Signature: _____

SECTION 01 00 00.10
GENERAL REQUIREMENTS - MAXWELL AFB
05/24

PART 1 - GENERAL

1.1 PROJECT SUMMARY

The work covered by these specifications consists of furnishing all plant, labor, equipment and materials and performing all operations in connection with the **REPAIR DINING FACILITY, BUILDING 668** to include all areas as indicated on drawings and in strict accordance with these specifications and applicable drawings and subject to terms and conditions of the contract.

The work generally consists of, but is not limited to, the renovating the entire building, to include the kitchen, with the addition to the building for new bathrooms, communications room and fire sprinkler room. Demolition includes the demolition for interior alterations, removal of windows and door systems at exterior openings, removal of the existing roof, demolition of building systems, and site demolition. New work includes new partitions and finishes throughout, windows systems, doors and door frames at exterior openings, a new roof assembly, new building systems, and sitework.

This project includes abatement of hazardous materials.

See Section 01 11 00 - Summary of Work for a more detailed summary.

1.2 BUILDING OCCUPANCY

Buildings will be unoccupied during the construction phase of this project, but the building and the site will be unavailable to commence the work until the ROTC season is complete. Contractor shall perform the majority of work during normal working hours. See Section 01 11 00 - Summary of Work.

1.3 SCHEDULE OF WORK

The Contractor shall be responsible for establishing a schedule to meet construction time. Contractor shall prepare a work schedule on forms provided for schedule of work. **Contractor shall have 640 calendar days to complete the work, but within the constraints of the directed phasing of the project.**

PHASING OF WORK: The work herein will be completed in two phases.

1.3.1 PROCURMENT PHASE: This phase will begin after NTP. During this phase, the Contractor shall procure all the materials to execute the work. The Contractor shall process submittals for Government review and coordination, and the Contractor will order and stage materials as required. Building 668 and the site will not be available except for verification of existing conditions, survey and documents. The dining facility in Building 668 will remain operational during this phase.

1.3.2 CONSTRUCTION PHASE: This phase begins after the ROTC season is complete (1 September). The Contractor will receive the facility and site of Building 668 after ROTC season is complete (1 September). The contractor will enable full operations to the government during the next period of ROTC operations, beginning 1 May.

1.4 CONTRACT DRAWINGS AND SPECIFICATIONS

The Contractor must comply with the contract clause entitled "Specifications and Drawings for Construction" (FAR 52.246-21). See Section 01 11 00 para 1.6 for "CONTRACT DRAWINGS AND SPECIFICATIONS DRAWINGS".

1.5 REMOVAL PROCEDURES:

No removed items will be reused in this contract unless specifically listed in these specifications and/or on the drawings. All removed equipment becomes the property of the Contractor unless noted otherwise.

See Section 01 74 19 - Construction Waste and Disposal.

REFER TO SPECIFICATION SECTION 01 00 01.10 - GENERAL REQUIREMENTS ENVIRONMENTAL PROTECTION

1.6 REFERENCED PUBLICATIONS

All publications referenced in these specifications, but may not be shown in each part under paragraph entitled "APPLICABLE PUBLICATIONS", also form a part of these specifications to the extent referenced.

1.7 ENVIRONMENTAL RELEASE REPORTING

An *Environmental Release Report* shall be completed for all environmental releases that are caused by an Air Force activity or which occur on an Air Force installation or facility. Examples of environmental releases are listed as follows but not limited to: oil releases to navigable waters, hazardous substance release above the reportable quantity, vinyl chloride releases, excessive emissions over amount allowed in permits, hazardous material incidents occurring during transportation, underground storage tank spills and releases, and any emergency incidents of environmental contamination. The Contractor shall immediately notify the TM/Contract Administrator in the event of any environmental release. The following information shall be documented: the time, type, amount, and cause of release.

1.8 PROTECTION OF EXISTING LANDSCAPE DURING CONSTRUCTION:

REFER TO SPECIFICATION SECTION 01 00 01.10 - GENERAL REQUIREMENTS ENVIRONMENTAL PROTECTION

1.8.1 Repair Or Replacement Of Damaged Landscape

If any failure to comply with these General Requirements Section or any other Contract Specification or provision or term of this contract occurs during installation, maintenance, or warranty, the Contractor shall be held responsible. Any damage occurring to Government property during the execution of this contract shall be repaired to the Government standards as defined in "The Maxwell Landscape Management Operational Instruction Manual" by the Contractor at no additional cost to the Government. The repair work shall be inspected and accepted by the Government. Any discrepancies shall be fixed before acceptance.

1.8.2 Requirements

The following requirements shall be observed by the Contractor in order to protect existing landscape (to include trees, shrubs, flowers, turf, flower beds, sidewalks, patios, fences, etc.) during construction operations.

No vehicle parking is all allowed under canopies or within the drip-line root zone of protected trees. All trees are to be protected unless they are shown to be removed on the plans.

No storage of materials will be allowed under protected tree canopies or beside existing shrub plantings.

1.8.2.1 No storage of materials on turf areas shall be allowed unless the Government has given Contracting Officer approval. If any lawn damage occurs (even with special permission), the Contractor shall restore the lawn per par. 25.02.2.4.05 below.

1.8.2.2 No driving across, parking, or other equipment operations on existing turf shall be permitted unless prior approval has been obtained from the Contracting Officer. If any lawn damage occurs (even with special permission), the Contractor shall restore the lawn

1.8.2.3 No pruning or breaking off existing trees or shrubs shall be permitted unless prior approval has been obtained from the Contracting Officer and Base Landscape Architect. If prior approval is not obtained, the Contractor is liable for the repair/replacement of any damaged landscape items.

1.8.2.4 No work shall damage the health of any tree whose roots extend into the construction area. No fences, ropes, cables, signs, or devices of any kind shall be attached to any tree.

1.8.2.5 The TM shall be notified immediately of any damage occurring to a tree in the construction site, or any tree damaged by Contractor personnel. The TM/Contract Administrator shall direct measures, if any, to treat the injury. The Government shall incur no cost for any corrective measures, including, but not limited to, removal and replacement of the tree.

1.8.2.6 If the Contractor causes the death or 60% decline to any protected tree(s) within a 24 month period, the Contractor shall remove and replace the damaged tree(s) with size and species of tree(s) directed by the TM. The size of the new tree(s) shall equal caliper size of removed tree(s).

1.8.2.7 Damaged turf areas shall be replaced with sod per "The Maxwell Landscape Management Operational Instruction Manual." The use of grass seed to repair turf damage at Maxwell AFB or Gunter Annex is not permitted.

1.9 STAGING AREA

During the Procurement Phase, the Contractor will be assigned a stage area in vicinity of Building 841 to begin stock piling equipment and supplies for the Construction Phase. During the Construction Phase, the Contractor's staging area will include the Procurement Area's staging area and the staging area indicated in the drawings.

An damages to the staging areas, construction sites and transportation routes due to the Contractor's activities on base will be repaired by the Contractor at no expense to the Government.

1.10 SECURITY REQUIREMENTS FOR UNCLASSIFIED CONTRACTS

See Section 01 11 00 - Summary of Work.

10.1 Traffic Laws

All Contractor personnel shall comply with Base traffic regulations.

10.2 Suitability Investigations

See Section 01 50 00 - Temporary Construction Facilities and Controls.

1.11 REQUIRED INSURANCE

See Section 01 30 00 - Administrative Requirements.

1.12 INSPECTION AND ACCEPTANCE

42 CES/CEN is designated as the office responsible for inspecting the work while the Contracting Officer is responsible for final acceptance of the work.

1.13 WARRANTIES

All workmanship, materials, and equipment shall be under warranty for at least one year as set forth in the contract clause entitled "Warranty of Construction" (FAR 52.246-21). See specs for warranties extending beyond the one-year period.

PART 2 - PRODUCTS

2.1 Building Entrance Signage.

Provide three building entrance signs in accordance with UFC 3-120-01, Change 4, Section 3-3.2 - Building Entrance Signs. Building entrance signs will include the building number and the facility name. Message to be approved by base architect. Confirm locations onsite with the base architect. Size of the sign, placement of the sign at the entrances to be selected, and the mounting height will be in accordance with Figure 3-14 - Building Mounted Entry Sign Placement in UFC 3-120-01.

PART 3 - EXECUTION

3.1 REPAIR OR REPLACEMENT OF DAMAGED PROPERTY

In the event of damages of any nature caused by this work (including maintenance and warranty operations) due to improper protection, precaution, or safety measures, such damages shall be repaired or such property shall be replaced by the Contractor at no expense, cost, or charge to the Government. In the event the Contractor does not satisfactorily repair or replace such damage caused by the work of the contract, the Government reserves the right to make the necessary corrections and deduct from the contract price the cost to the Government for inconveniences, labor material, etc. involved. Reference contract clause "Protection of Existing Vegetation, Structures, Equipment, Utilities, and Improvements" (FAR 52.246-9).

1.12.1 Contractor shall protect all communications cabling while working and if damage is caused by the contractor, then the contractor shall replace the damaged communications cabling with same, or for internal cable, base standard CAT 6 cable. All CAT 6 cable must be home run to the communications room. Copper tie cables must be replaced with same. Fiber optic cables must be a continuous strand with no splices. All communication cabling must be wired to T568B standard.

3.2 FINAL CLEANING

1.13.1 Cleaning Schedule

Execute final cleaning prior to the final inspection.

1.13.2 Procedures

1.13.2.1 Clean surfaces exposed to view.

1.13.2.2 Remove temporary labels, stains, and foreign substances; polish transparent and glossy surfaces; wet mop tile or sealed concrete floors, vacuum carpeted floors, broom clean other floors.

1.13.2.3 Clean equipment and fixtures to a sanitary condition.

1.13.2.4 Clean or replace filters of mechanical equipment.

1.13.2.5 Any additional cleaning as specified in other sections.

1.13.2.6 Clean sites of all construction related and project related debris.

1.13.2.7 Remove waste and surplus materials, rubbish, and construction facilities from the work areas and the site.

3.3 CLOSEOUT PROCEDURES

When the Contractor is ready for final inspection, the Contractor shall notify the Contracting Officer (in writing) within two (2) working days of the desired inspection date. During the inspection, the Contractor and the TM/Contract Administrator shall document all deficiencies on a "punchlist." The Contracting Officer will provide a formal copy of the punchlist to the Contractor. The Contractor shall be responsible for correcting all punchlist items prior to the end of the contract completion date and notify the Contracting Officer (in writing) when

the contractor is ready for re-inspection.

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SECTION 01001A
EXHIBIT L
ENVIRONMENTAL PROTECTION

PART 1 GENERAL

1.0 DESCRIPTION

The work covered by this section consists of furnishing all labor, materials, and equipment and performing all work required for the prevention of environmental degradation during and as a result of construction operations under this contract. These requirements are in addition to any environmental protection requirements elsewhere in these specifications. For the purpose of this specification, environmental pollution is defined as the presence of chemical, physical, or biological elements or agents, not naturally occurring at the site, which adversely affect human health or welfare; unfavorably alter ecological balances; negatively affect plant or animal species; or degrade the utility of the environment for aesthetic and recreational purposes. The control of environmental pollution by the contractor requires consideration of air, water, and land, and involves noise control, solid waste management and management of radiant energy and radioactive materials, as well as other pollutants. This section also requires the protection of natural, cultural and historic resources.

1.1 ACRONYMS AND DEFINITIONS

ADEM – Alabama Department of Environmental Management CAA – Clean Air Act

CO – Contracting Officer

CERCLA – Comprehensive Environmental Response, Compensation and Liability Act

CWA – Clean Water Act

EPA – Environmental Protection Agency

MAFB – Maxwell Air Force Base and Gunter Annex. Throughout this environmental protection section, MAFB (including Gunter Annex) may commonly be referred to as the base or installation.

Media – Any soil, water, or air that is moved, disturbed, or released from a site

OSHA – Occupational Safety and Health Administration

TM – Technical Manager

RCRA – Resource Conservation and Recovery Act

SDWA – Safe Drinking Water Act TSCA – Toxic Substances Control Act

42 CES/CEIE – Maxwell Air Force Base Civil Engineering Squadron, Environmental Section. Throughout this environmental protection section, this office will commonly be referred to as the “installation environmental office.”

The terms *hazardous*, *waste*, *pollutant*, *contaminant*, and *substance* have the same meanings and usage here as they commonly do in the CAA, CERCLA, RCRA, SDWA, and TSCA.

1.2 CONTRACTOR’S GENERAL ENVIRONMENTAL COMPLIANCE OBLIGATIONS

1.2.1. Work under this contract is to be performed on a government facility. All environmental

rules applying to contractor operations elsewhere shall also apply on the government facility. Contractor (and any of their additional contractors, agents or representatives) shall comply with all applicable Federal, State, and local laws and regulations providing for environmental protection and pollution control and abatement. These include but are not limited to: the Clean Air Act, Clean Water Act, Resource Conservation and Recovery Act, Comprehensive Environmental Response, Compensation and Liability Act, Toxic Substances Control Act, Federal Insecticide Fungicide and Rodenticide Act, Coastal Zone Management Act, Endangered Species Act, Migratory Bird Treaty Act, National Historic Preservation Act, Archeological Resources Protection Act, Safe Drinking Water Act, Emergency Planning and Community Right-to-Know Act, Oil Pollution Act, and Pollution Prevention Act. Contractor has the duty to determine where such laws and regulations apply. Although the contractor may request assistance from the TM/Contract Administrator or the installation environmental office in delineating applicable environmental laws and regulations, contractor has an independent responsibility to make its own determination and to do so in a timely fashion. Environmental Management System (EMS) significant aspect is Hazardous Waste Compliance. Please ensure all personnel are aware of applicable RCRA requirements and have reviewed the Commander's Policy at the end of this section.

- 1.2.2. Contractors are responsible to implement their own environmental compliance programs, to ensure that individuals working at the site are properly trained and aware of potential hazards and proper operating procedures, and to ensure that all personnel follow the guidelines of OSHA, EPA, ADEM, and the Air Force's policies, in addition to any guidelines of the jurisdiction(s) in which the operations will be performed. Compliance with the provisions of this section by lower tier contractors will be the responsibility of the contractor.
- 1.2.3 Notification: The Contract Administrator will notify the Contractor in writing of any non-compliance with environmental provisions and the action to be taken. The Contractor shall, after receipt of such notice, immediately take corrective action. If the Contractor fails or refuses to comply promptly, the Contract Administrator may issue an order stopping all or part of the work until satisfactory corrective action has been taken. No part of the time lost due to any such stop orders shall be made the subject of a claim for extension of time or for excess costs or damages by the Contractor unless it was later determined that the Contractor was in compliance.
- 1.2.4 Maintenance of Pollution Control Facilities During Construction: During the life of this contract, the Contractor shall maintain all facilities constructed for pollution control under this contract as long as the operations creating the particular pollutant are being carried out or until the material concerned has become stabilized to the extent that pollution is no longer being created.

1.3 FINES OR PENALTIES FOR ENVIRONMENTAL NON-COMPLIANCE

The contractor shall be responsible for paying any fines or penalties assessed against the Government for violations of environmental laws or regulations resulting from acts or omissions of the contractor or its employees, contractors, or agents. This obligation is in addition to any fines or penalties that may be assessed against the contractor for the same conduct. Contractor shall either reimburse these fines or penalties through the appropriate Contract Administrator, or with the consent of the Contracting office and installation environmental office, the Contractor shall pay such fines or penalties directly to the regulatory agency or agencies concerned.

1.03.1 Pollution Reporting: No hazardous material can be released into the environment (ground, water, air) without prior approval of the contractor. In the event of an accidental release of a hazardous material to any of these medias, the contractor will be notified immediately. The contractor will supply the means to properly prevent/contain and dispose of an accidental release in accordance with all applicable Federal, State, and Local regulations. All costs incurred by the contractor during the mitigation and disposal from an accidental release shall be the responsibility of the contractor.

1.4 CONTRACTOR'S LIABILITY FOR ENVIRONMENTAL DAMAGES

Contractor agrees to hold harmless and indemnify the Government for any and all damages of any kind resulting from environmentally harmful activities by the contractor, contractor's employees, agents, or contractors. "Damages" includes personal injury or death, property damages (including diminution of value), environmental restoration and response costs, natural or cultural resource damages or restoration, expert witness and attorney's fees, and reimbursement of any and all expenses incurred to obtain permits as a result of contractor's failure to identify or obtain permits for itself, the Government.

1.5 CONTACT WITH ENVIRONMENTAL REGULATORY OFFICIALS

Contractor shall immediately advise the TM/Contract Officer, 42nd Contracting Office, and the installation environmental office of the content of all contacts with Federal, State, or local environmental regulators; before, during, and after the performance of this contract concerning the performance of this contract.

1.6 PERMITS FOR EQUIPMENT USED BY CONTRACTOR IN PERFORMING GOVERNMENT CONTRACTS.

For equipment used in the performance of this contract, contractor shall obtain in contractor's name and at no additional expense to the Government all permits, coordination, certifications or other regulatory authorization necessary to perform and complete the work required by this contract under applicable environmental laws and regulations. "Applicable environmental laws and regulations" includes but is not limited to: the Clean Air Act, Clean Water Act, Resource Conservation and Recovery Act, Comprehensive Environmental Response, Compensation and Liability Act, (CERCLA), Toxic Substances Control Act, Federal Insecticide Fungicide and Rodenticide Act, Coastal Zone Management Act, Endangered Species Act, National Historic Preservation Act, Safe Drinking Water Act, Emergency Planning and Community Right-to-Know Act, Oil Pollution Act, and Pollution Prevention Act, and State, County, and Local laws and regulations on the same subjects.

1.7 PERMITS NEEDED FOR CONSTRUCTION, EXCAVATION, MODIFICATION, RENOVATION, DEMOLITION, INSTALLATION, OR OTHER ALTERATION OF BUILDINGS, STRUCTURES, EQUIPMENT, INSTALLATIONS, REAL PROPERTY OR SYSTEMS

Contractor shall identify all Federal, State, County, or local permits, coordination, certifications or other regulatory authorization requirements under all applicable environmental laws and regulations. Contractor shall then prepare in draft, and submit to the Contracts office for review, all applicable permit applications, coordination, notices, or other required filings, together with all supporting data. Permit applications, notifications or other documents that must be submitted by

the Government shall be submitted by the Government, and any documents that must be submitted by the contractor shall be returned to the contractor for submission after review. No work requiring permit or other written authorization shall proceed before the contractor has the permit or authorization or a copy thereof in its possession. Copies of all required environmental permits shall be submitted to the Contracts office to be forwarded to the installation environmental office to have on file **prior to the start of work.**

PART 2 MATERIALS

2.1 ASBESTOS

- 2.1.1. Asbestos shall not be used or included in this project unless specifically approved in writing by the 42nd Contracting Office and installation environmental office.
- 2.1.2. If workers should encounter any suspect asbestos-containing material such as fibrous insulation, pipe wrap, asbestos-containing plaster, etc., contractor shall cease any activity that may disturb the material and immediately contact the TM/Contract Administrator for coordination with the installation environmental office.
- 2.1.3. If potential asbestos-containing material has been identified in connection with proposed work, all asbestos abatement activities shall be conducted by a certified Safe-State contractor, following base asbestos protocol, asbestos specification section, *Maxwell AFB Asbestos Management and Operations Plan*. Contractor shall follow all applicable governing regulations, including, but not limited to: 29 CFR 1926.1101 - *OSHA Safety and Health Regulations for Construction, Subpart Z, Toxic and Hazardous Substances*, 29 CFR 1910.1001 - *OSHA Standards, Subpart Z, Toxic and Hazardous Substances*, and CFR Part 61 - *EPA National Emission Standards for Hazardous Air Pollutants (NESHAPS)*

2.2 POLYCHLORINATED BIPHENYLS (PCBs)

- 2.2.1. PCBs shall not be used or included in this project.
- 2.2.2. If contractor encounters any lighting ballasts, electrical transformers, or other equipment that is suspected to contain PCBs, contractor shall contact the TM/Contract Administrator for notification to the installation environmental office. If the equipment is not labeled or does not specify that the unit has "no PCBs," it is considered to be suspect and shall be handled as if it may contain PCBs. Disposal shall be coordinated through installation environmental office. Contractor shall not remove any hazardous waste from the installation without installation environmental office knowledge prior to scheduling.

2.3 LEAD-BASED PAINT

- 2.3.1. Lead-based paint shall not be used or included in this project.
- 2.3.2. In buildings that were constructed prior to 1978, it should be assumed that lead-based paint is present unless sampling results indicate otherwise. Any activities that will potentially disturb lead-based paint shall be coordinated through the installation environmental office. Contractor is responsible for complying with the *Maxwell AFB Lead-Based Paint Management Plan* and all applicable Federal, State, and local regulations, including OSHA *Lead in Construction Standard* 29 CFR 1926.62. Contractor shall be properly trained and is responsible for worker training and protection requirements. Documentation of training shall be provided to the 42nd Contracting Office prior to start of work.

- 2.3.3. If suspect lead-based paint is encountered during performance of work, contractor shall coordinate lead-based paint work plan through TM/Contract Administrator for coordination with installation environmental office before proceeding with any activities such as sanding, scraping, demolition, or other activities that may disturb lead-based paint.

2.4 OZONE-DEPLETING SUBSTANCES

- 2.4.1. The use of Class I ozone-depleting substances is generally prohibited. Any use of a Class I ozone-depleting substance shall be approved through the installation environmental office prior to use. All Class I ODSs recovered on site shall be returned to the base Civil Engineering HVAC shop (42 CES/CEOH). All reasonable efforts shall be made to reduce usage of Class II ozone-depleting substances. All usage shall be reported to 42 CES/CEIE.
- 2.4.2. Contractors shall follow regulations concerning ODS as specified in 42 USC 7671 (b), (c), and (d) and 40 CFR Part 82, Subpart E. All Class I and Class II ODS shall be labeled IAW these regulations.
- 2.4.3. The contractor shall comply with the applicable requirements of Sections 608 and 609 of the Clean Air Act (42 USC 7671g, National Recycling and Emission Reduction Program and 7671h, Servicing of Motor Vehicle Air Conditioners) as each or both apply to the contract.

2.5 PESTICIDES

Except as may be specified elsewhere in this contract, contractor shall not use or apply pesticides (such as insecticides, rodenticides, herbicides or weed-killers) without specific written prior approval of the TM/Contract Administrator.

2.6 HAZARDOUS MATERIALS, POLLUTION PREVENTION & WASTE MINIMIZATION

When a hazardous material is required in performance of this contract, the contractor is required to submit *Contractor's Hazardous Material Questionnaire*, *Contractor's Environmental Reporting Entry Form*, and Material Safety Data Sheets (MSDS) for each hazardous material to be used. The hazardous material must be approved prior to being brought onto Maxwell AFB or Gunter Annex.

The approval process should be less than 2 days in order to comply with the 10-day suspense time to receive submittals 5 days prior to contract start date. See AF Form 66.

PART 3 EXECUTION (WORK PRACTICES)

3.1 SITE DISTURBANCE DURING CONSTRUCTION ACTIVITIES

- 3.1.1. National Pollutant Discharge Elimination System (NPDES) - For any project that will disturb an area "equal to" or "more than" 1 acre, the contractor is required to submit an ADEM Notice of Intent (NOI) under the NPDES General Construction Permit. A completed copy of the NOI must be submitted to the 42nd Contracting Office and Environmental Department prior to any site work. The "site" encompasses the collective area of disturbance for any project, even if the disturbed areas are non-contiguous. The contractor is responsible for all required inspections under ADEM's NPDES General Permits. However, Base Environmental will perform additional oversight inspections and instruct changes, alterations and/or modifications as necessary.

3.1.2. The contractor shall use industry recognized Best Management Practices (BMPs) to the maximum extent practical to avoid and control storm water runoff from the construction site and any temporary roads that may be used to access the site (entrances/exits). Contractor shall perform all work under this contract in such a manner that no pollutants of any kind are released into ditches, storm drains, streams, lakes, or other surface waters on or connected to the site. BMPs shall be implemented prior to site disturbance and maintained throughout project duration until permanent stabilization has been achieved. Protective measures shall include:

3.1.2.1. Silt Fencing: Install silt fencing around all storm drains and runoff channels that can be potentially impacted by the construction/demolition activity. Install silt fencing where appropriate and to the maximum extent necessary to prevent removal of particulates and debris with runoff from the site. Refer to the ADEM Handbook for Type A, B and C methods.

3.1.2.2. Wattles: Install wattles in front of curb inlets that will be impacted when sediment run-off is inevitable due to tracking, equipment and supply staging areas and/or other disturbed areas. Wattles shall be in lengths that cover entire inlet opening. Contract Administrator does not recommend blocking curb/street inlets unless absolute necessary. Blocking street inlets will cause temporary ponding which may impact traffic flow. The contractor must make all reasonable attempts to maintain sediment on the construction site to eliminate having to protect street inlets. Wattles are an acceptable practice when protecting drop inlets located in landscaped areas where stakes can be used to hold the wattles in place on a disturbed construction site. Straw wattles shall not be used for drop inlet protection on concrete or asphalt pavement areas

3.1.2.3. Silt Savers: Install silt savers as a primary means for drop inlet protection within the disturbed areas of a construction site. Silt savers come in round or square molds depending on the drop inlet configuration and size. Crushed stone and/or soils shall be used to support the mold and filter fabric in place. Install as per manufacture recommendations..

3.1.2.4. Hay Bales: Place and stake hay bales or other temporary dams where appropriate for impeding storm water flow across large, open areas of disturbed earth and as particulate barriers to prevent erosion and unintended soil relocation. Hay bales shall not be used as a sole source when protecting drop inlets. Silt fencing and/or crushed stone shall be used in support with hay bales to prevent entry of sediment and any construction debris during the activity. Hay bales shall not be used to protect curb inlets.

3.1.2.5. Block and Gravel: Install block and gravel inlet protection where an impermeable surface (concrete, asphalt, etc.) exists around the drain and in other areas where this type protection is more appropriate to prevent particulate transport to the inlet. The height of the block and gravel inlet structure shall be a minimum of 12 inches. A geotextile fabric shall also be placed as a filter between the block and crushed stone (ALDOT #57 crushed stone or similar grade shall be used).

3.1.2.6 Geotextile Fabric (drop inlet barriers):

The contractor may use a non-woven geotextile fabric as a means to protect drop inlets with metal grates. The drop inlet grate can be removed in order to place a sufficient amount of geotextile fabric inside the storm inlet opening. The grate must be replaced on top of the fabric maintaining a tight fit with no gaps in order to provide a sock-like barrier. Excess fabric shall drape outside the grate allowing for any sediment to be captured. This method allows for construction traffic but must be maintained. Sediment overloaded geotextile fabric must be cleaned and replaced as needed.

3.1.2.7. Stabilization: All disturbed and exposed soils shall be preserved, covered if

needed, in a manner that prevents soil migration with rainfall or runoff. Contractor is responsible for repair of any erosion caused by the contractor's construction activities. All disturbed or exposed soil shall be permanently stabilized at the earliest practicable date. In most cases, seeding is not allowed on the installation; areas shall be repaired with sod, re-vegetation shall be with non-invasive plants that are native species or approved turf species.

3.1.2.8 Concrete & Asphalt Saw-Cutting: The contractor shall implement means and methods to control and clean-up from saw-cutting activities immediately and not allow for traffic to travel through the saw cut locations until the "saw-cut mud" clean-up activities are completed. **Washing into the nearest storm drain is prohibited.**

3.1.2.9 Concrete Wash-Outs: The contractor must have a location on site or at an approved location by the TM/Contract Administrator where concrete trucks can wash out. The location must be in an area that will not allow the wastewater to flow or drain into storm inlets, drainage ditches, waterways or roadways. For large projects where multiple concrete placements will be performed, a wash out location must be designated and protected. Typically this is created by using a soil berm and combining with the use of hay bales, silt fencing, and/or wattles.

3.1.2.10 Materials & Fuel Storage: The contractor must maintain a clean and orderly project site and laydown yard with regards to materials storage. Containers with liquids, oils, lubricants, fuels and other materials must be properly covered and/or stored on site and protected from rainfall and inclement weather. Spill prevention controls and spill response materials must be available and/or on hand in case of a spill. Base Environmental must be notified of any spill for documentation, instructions for clean-up and disposal requirements.

3.1.2.11 Soil, Sand, and Crushed Stone Stock Piles: The contractor must store stock piles in a manner and in a location where sediment run-off will not leave the site. Storm inlets must be protected in affected or in adjacent areas with the use of silt fencing, wattles, berms and/or a combination of thereof, unless sediment control can be maintained on site.

3.1.2.12 Dust Control: Water shall be used in a manner to control dust during dry periods of the year and continuous during demolition activities. The amount of water used shall be monitored by the contractor. Excess water can create additional problems.

3.1.2.13 Construction Entrances/ Exit Pads: The contractor shall construct an adequate construction entrance/exit pad to protect from vehicle and construction equipment tracking onto roadways, parking lots and other impermeable hard surfaces. A layer of non-woven geotextile fabric shall be placed in a designated location(s) for the project. ALDOT #1 crushed stone shall be placed with a minimum thickness of 6 inches on the fabric. The pad must be constructed to an adequate length and width for the project traffic and equipment. The contractor **shall not** use crusher run, river gravel, or small crushed stone such as ALDOT #57 or #67 stone. This material compacts and thus does not provide an adequate surface for flexing rubber tires to remove mud and sediment. It is the responsibility of the contractor to maintain and replace the crushed stone when conditions do not provide adequate protection

from off-site tracking.

3.1.3 ENFORCEMENT MECHANISM – CONSTRUCTION SITE STORM WATER RUNOFF CONTROL

3.1.3.1 All project sites will be subject to inspections by CEIE and/or CE project managers. Documenting inspections and non-compliance issues will occur on monthly summary reports to the Government Quality Assurance Evaluator (QAE) for Maxwell AFB.

3.1.3.2 If site condition(s) warrants an instruction for correction or implementation of a BMP, this item will be verbally discussed between the Contract Administrator, the contractor's representative, the CEIE representative and the CE project manager. Instructions will be given if a site condition is, or has the potential to become, a NPDES non-compliance issue. The contractor will be given a deadline by which to implement, change and/or fix the issue, depending on the finding.

3.1.3.3 A follow up inspection by CEIE or the CE project manager will be performed to observe for site corrections. If the site correction has not been implemented or fixed due to a lack of effort, lack of concern or contractor negligence, then a written warning will be documented and placed on file. The contractor will be given a warning letter and a final deadline for implementing the mandatory instruction.

3.1.3.4 If, on a 2nd follow up site inspection, the contractor has not completed the Base's instruction, a work stoppage, at the contractor's loss of time, will be enforced until the compliance issue or issues have been addressed.

3.1.3.5 If more than one work stoppage has to be enforced for a single project, due to non-compliance issues, the general contractor will be subject to removal from all future bid lists for a time determined by the Contract Administrators.

3.1.3.6 The above process can be used as guidance for all projects. However, CEIE and CE reserve the right to work with contractors on a project-to-project basis, based on special conditions. Special conditions may be determined by CEIE and CE. Special conditions may include, but are not limited to, situations such as the following:

- A. Unforeseen weather conditions. (i.e. flooding, severe thunderstorms with significant rainfall events, etc...)
- B. Vandalism
- C. Contractor making continuous efforts to comply with standards, using means and methods typically applied in the construction industry, and exhibiting an overall concern with maintaining a site in compliance with the Base and under State guidelines.

3.1.3.7 A maintenance plan should be developed to address issues that need immediate corrections, which may result in off-site discharges, when the contractor is not on Base, refuses to return in a timely manner to make corrections and/or cannot be contacted. These issues include, but are not limited to, the following: silt fence repair, street sweeping, inlet protection, etc... The cost of these corrections could be passed on to the contractor, if the contractor is found to be at fault due to negligence.

3.2 OTHER PROTECTION OF WATER RESOURCES

- 3.2.1. **GENERAL:** The contractor shall not pollute storm drainage, streams, lakes, or reservoirs with fuels, oils, bitumen, calcium chloride, acids, construction wastes, or other harmful materials or pollutants. It is the responsibility of the contractor to determine and comply with all applicable Federal, State, regional, municipal, and other regulations.
- 3.2.2. **SPILLAGE:** The contractor shall take special measures to prevent chemical, fuels, oils, greases, bituminous materials, waste washings, herbicides, paints, cement, and surface drainage from entering public waters. In the event of a spill, the contractor must first notify the Maxwell AFB Fire Department (334-953-9911), and then notify the TM/Contract Administrator and the installation environmental office. Contractor is responsible to make all required notifications to Federal, State, or local authorities as soon as possible.
- 3.2.3. **WASHING AND CURING WATER:** Water used in aggregate processing, concrete curing, foundation, and concrete lift clean-up and other waste water shall not be allowed to enter the storm drainage system.
- 3.2.4. **PAINTING:** Contractor shall provide sufficiently-sized drop cloths at each job site to contain any accidental spillage during paint usage. All containers shall be placed on drop cloths before opening and at all times during use. Any unused paint and its containers brought onto the installation by the contractor shall be properly sealed and taken off the installation by the contractor upon completion of the job.
 - 3.2.4.1. **Latex Paint:** Locations (sanitary waste drains/entry points) for cleaning of brushes and other paint application equipment are confined to only those designated by installation environmental personnel for the particular job. At the designated sanitary waste disposal site, the volume of water used for cleaning shall be sufficient to provide for adequate dilution of the paint material.
 - 3.2.4.2. **Oil-Based Paint, Polyurethane, and Other Chemicals or Cleaning Solutions:** Contractor shall properly dispose of all oil-based paint, polyurethane, cleaning solutions, containers, and used applicators at an off-base site.
- 3.2.5. **CARPET CLEANING:** Contractor shall vacuum-extract or otherwise capture all cleaning fluids and chemicals applied to carpet during cleaning procedure. Fluids shall be collected in a portable tank and transported off the installation for proper disposal in accordance with all applicable regulations. No material or fluid used in carpet cleaning activities shall be disposed of anywhere on the installation.

3.3 PROTECTION OF LAND RESOURCES

General: It is intended that the land resources within the project boundaries and outside the limits of permanent work performed under this contract be preserved in their present condition or be restored to a condition after completion of construction that will appear as the natural state and not detract from the appearance of the project. The contractor shall limit his construction activities to areas defined by the Drawings or Specifications.

3.4 CONTROL OF AIR EMISSIONS

- 3.4.1. Contractor's actions shall conform to all applicable State, Federal, Air Force and MAFB requirements and directives for the control of air emissions under this and all contracts to be executed within the boundaries of Maxwell-Gunter AFB and associated GSU's. When installing, servicing or operating air pollution producing equipment, all work shall be completed in accordance with manufactures specifications to ensure optimal operation

and minimal emissions to the environment. When new or remanufactured equipment, including boilers and generators, is being installed, all necessary specifications and documentation

required to calculate air emissions shall be provided to 42 CES/CEIE 60 days prior to installation. Required emissions data consists of unit capacity, input rating, output rating, and low emissions modifications.

3.4.2. Burning shall only be permissible when approved in writing by a approved in writing by the Contracting Officer in conjunction with a representative from 42 CES/CEIE. All burning operations shall conform with applicable State, Federal, Air Force and MAFB requirements and directives. It shall never be permissible to burn or allow the burning of any plastic, rubber, paper, treated lumber or other material that is not vegetative waste generated on the project site.

3.4.3. Dust control measures shall be employed when necessary to control dust production on a work site. Vehicles leaving the site shall have all practical amounts of dust/dirt removed by brushing, washing or other equally effective method to ensure that generation of airborne dust due to vehicle movement and tracking onto roadways is minimized. All bulk containers of loose material to be moved to or from a work site shall be covered to minimize airborne dust during transport.

3.5 WASTE DISPOSAL

3.5.1. GENERAL: Installation environmental office shall be notified 24 hours before any waste will be allowed to leave the facility. Recurrence of pickups can be scheduled for the duration of the project or throughout current fiscal year. All waste containers shall be properly labeled in accordance with applicable regulations. Quantity of waste materials shall be provided to the 42nd Contracting Office and installation environmental office.

3.5.2. HAZARDOUS WASTE GENERATION, HANDLING, AND DISPOSAL: Work done under this contract is to be performed on a government facility. According to rules and procedures of the United States Environmental Protection Agency, the Federal facility is required to have a generator identification number under the RCRA and to be responsible for wastes (as defined under RCRA and TSCA) produced, managed, stored, disposed on, or transported from the facility. Contractor shall, to the greatest extent practicable, use materials, processes, and techniques that will avoid the creation of hazardous waste. Under no circumstances shall contractor bring onto the site hazardous waste that has been generated elsewhere. No hazardous waste, petroleum waste, or universal waste shall be disposed of in solid waste containers.

Prior to generation of any hazardous wastes, contractor shall prepare and submit a written waste management and disposal plan for all hazardous wastes generated on the site, and all planned activities regarding hazardous materials and hazardous waste shall be coordinated through the Contract Administrator with the installation environmental office. Contractor shall follow this plan once it has been approved in writing by the CO in conjunction with the environmental office and shall dispose of all hazardous waste in accordance with all Federal, State, and local requirements. **Contractor shall coordinate and schedule all disposal of hazardous waste through the CO in conjunction with the installation environmental office. Installation environmental office must authorize, on site, all shipments of hazardous waste from Maxwell Air Force Base.**

3.5.3. DISPOSAL OF NON-RCRA WASTES: All non-hazardous wastes generated on the site as

a result of this contract shall be disposed of properly, in accordance with all Federal, State, and local requirements. Prior to creation of such wastes, the contractor shall submit to the installation environmental management function, through the TM/Contract Administrator, a plan for disposal of wastes. Such plan shall include the types of waste to be created, estimated quantity expected, how they shall be stored, managed and disposed. Contractor shall follow this plan once it has been approved by the installation environmental office and TM/Contract Administrator. Such wastes shall not be created until approved by the TM/Contract Administrator. Unless specified otherwise in the contract, non-hazardous waste shall be disposed of off base by the contractor in a legal manner that will not result in liability to the United States Air Force. Waste manifest, Bill of Lading, and/or landfill receipt shall be provided to the 42nd Contracting Office for forwarding to installation environmental office.

- 3.5.4. **CONSTRUCTION DEBRIS:** This contract may require the contractor to remove clean construction debris from the site and dispose of the debris off the installation in a manner that is in compliance with all applicable Federal, State, and local regulations. (Site soil, water, or other site media are not covered by this paragraph.) Such debris shall be free of all contamination, including but not limited to, lead paint, asbestos, and insecticides. Prior to removal of any construction debris, that debris shall be certified by an installation representative to be free of contamination and this certification shall be provided to the TM/Contract Administrator. To expedite work, this may be accomplished by a FAX, or other suitable electronic means; however, the original certification form shall be provided to the TM/Contract Administrator. All necessary information shall be provided and the document shall be signed by an authorized installation representative. The certification form is provided at the end of this section of the specifications. All construction debris removed from the installation shall be covered by a certification. The contractor shall arrange with the installation point of contact whether all debris will be covered by one certification or if several certifications will be required.
- 3.5.5. **RECYCLING:** Contractor shall recycle material to the greatest practicable extent in order to reduce disposal of solid waste. Where construction and/or demolition debris such as concrete, brick, asphalt, wood, carpeting, or other material can be recycled, this alternative will be considered. Contractor shall submit weight verification of recycled/reclaimed material to the 42nd Contracting Office for submission to the installation environmental office for solid waste diversion tracking.
- 3.5.6. **ORGANIC WASTES:** Organic waste from ground-clearing operations may usually be disposed of at the installation compost facility. Contractor shall check with the TM/Contract Administrator for final clearance.
- 3.5.7. **CONSOLIDATED WASTE DISPOSAL PLANS:** Contractor may, at contractor's option, submit for approval as specified above one consolidated plan for handling hazardous and non-hazardous wastes.

3.6 EARTHWORK AND REMOVAL OF POTENTIALLY CONTAMINATED MEDIA:

- 3.6.1. **ENCOUNTERING UNEXPECTED CONTAMINATED SOIL OR GROUNDWATER:** Unless otherwise specified elsewhere in this contract, the site has been inspected and is, consistent with best professional judgment, free of environmental contamination or pollution. However, work under this contract will be performed on a military installation, where the history of prior military and industrial activities is not necessarily completely known, and unexpected conditions can always arise. Contractor or contractor personnel may encounter soil or groundwater that is suspected to be contaminated, either because of odors, colors, free liquids, unexpected construction debris, or other suspicious conditions.

Should this occur, contractor shall cease activity in the area except those initial actions necessary to protect workers, the site, and other personnel. Contractor shall then immediately notify the TM/Contract Administrator and the installation environmental office at 334-953-5260.

- 3.6.2. Chlordane: Facilities proposed for demolition, significant renovation, and /or additions that were constructed prior to 1990, will be suspect for the presence of chlordane and other pesticides. It is known that chlordane has been used on Maxwell AFB as a pesticide prior to its EPA ban in 1989. We require that soils around the building foundations be tested for the presence of pesticides (chlordane). The EPA has specific handling and disposal requirements for soils and/or any waste streams that have been contaminated with chlordane that exceed threshold limits. Any suspected chlordane-containing soil will be subject to these provisions.
- 3.6.3. REMOVAL OF POTENTIALLY CONTAMINATED MEDIA: The following provisions prohibit the removal from the installation of potentially contaminated soil or other materials found on site and are included, in an abundance of caution, for the protection of the Government, the installation, and the contractor.
 - 3.6.3.1. Notwithstanding any another clause in this contract, including but not limited to all standard site work general provisions; no media by-product resulting from site preparation, construction or excavation shall be moved off the installation where the construction is occurring without written permission from CO. If the construction is off the installation, no media by-product shall be moved off the construction site.
 - 3.6.3.2. The contractor shall: (1) leave the media in place at the site, subject to appropriate erosion control; or (2) haul the media to, and place it at, a location on the installation that has been designated either in this contract or in writing by the TM/Contract Administrator; and (3) if unforeseen difficulties arise, such as excessive quantity of media is generated, the contractor shall advise the TM/Contract Administrator and shall not remove media from the site without written authorization from the CO.

PART 4 - RESOUC E PROTECTION

4.1 RESOURCE CONSERVATION

Consumption of resources shall be minimized where possible. Contractors shall shut down electrical and gas-powered equipment when not in use and minimize the consumption of water and other resources.

4.2 PROTECTION OF CULTURAL/HISTORICAL RESOURCES

- 4.2.1. HISTORIC FACILITIES: Modifications or renovations to any facilities on Maxwell-Gunter AFB that are listed on or eligible for the National Register of Historic Places or exceed 50 years in age must be reviewed and approved by the installation Cultural Resource Manager. If the proposed action affects any elements that contribute to the facility's historical characteristics, these actions are subject for review and approval by the State Historic Preservation Office (SHPO). Plans and drawings for projects that will impact historic facilities shall be submitted to installation environmental office for potential submission to SHPO. SHPO review is a minimum of 30 days, and work shall not proceed until authorized through the CO in conjunction with the installation environmental office. If the contractor or contractor's representative causes any damage to historical characteristics of a historic facility, contractor shall be responsible for full restoration of

damage.

- 4.2.2. UNEXPECTED ARTIFACTS OR RELICS: Should contractor or employees, in the course of site preparation or other work on this contract, find unexpected historic or archeological remains, such as bones, arrow points, pottery remnants, foundations, or other evidence of previous uses of the site, contractor shall cease further site-disturbing activity and immediately notify the TM/Contract Administrator and installation environmental office.

4.3 PROTECTION OF NATURAL RESOURCES

- 4.3.1. PROTECTION OF SPECIAL WATER RESOURCES: If project will involve: any disturbance below the ordinary high water mark of a pond, lake, stream, river, or other water body; any work within wetland areas; withdrawal of water from water bodies; or discharges into water bodies; planned work shall be coordinated through installation environmental office. Contractor shall obtain any required Federal, State, or local permits and submit copy of permit(s) to installation environmental office prior to work start.
- 4.3.2. PRESERVATION OF TREES, SHRUBS, AND OTHER LANDSCAPE: The following requirements shall be observed by the contractor in order to protect the existing landscape (to include trees, shrubs, turf, flowers, flower beds, sidewalks, patios, fences, etc.):
- 4.3.2.1. Tree Protection: All trees shall be protected unless they are designated on the plans to be removed. Contractor shall install protective fencing around trees in the construction area, at a radius extending from the tree trunk at least out to the drip line of the tree. No vehicle parking or storage of materials is allowed under tree canopies or within the drip line/root zone of the trees or beside existing shrub plantings. Work shall not damage roots of existing trees without prior coordination with installation Natural Resources Manager. No fences, ropes, cables, signs, or devices of any kind shall be attached to any tree. Pruning or removal of trees/shrubs shall only be permitted after written or electronic coordination with the Natural Resources Manager in the environmental office or the Horticulturist at the installation greenhouse. The TM/Contract Administrator and installation environmental office shall be notified immediately of any damage to trees caused by contractor or contractor's representative. The 42nd Contracting Office will direct measures, if any, to treat the injury. If the contractor or contractor's representative causes the death or 60% decline to any protected tree(s) within a 24-month period, the contractor shall remove and replace the damaged tree(s) with size and species of tree(s) directed by the 42nd Contracting Office. The size of replacement tree(s) shall equal caliper size of removed trees. Contractors shall replace trees in accordance with the AETC Tree Instruction, AETCI32-7065.
- 4.3.2.2. Turf Protection: No driving across, parking, or other equipment operations on existing turf or storage of materials on turf areas shall be permitted unless prior approval has been obtained from the TM/Contract Administrator. If any lawn damage occurs (even with special permission), the contractor shall restore the lawn with approved sod. (Turf in most areas is Tifton 419 Bermuda grass.) If sod fails to grow or is not viable within 60 days of the date of substantial completion of the contract, sod shall be replaced at contractor's expense. The use of grass seed to repair turf damage is not permitted.
- 4.3.3. REPAIR OR REPLACEMENT OF DAMAGE: If any failure to comply with these environmental protection provisions or any other provisions of this contract results in damage to government resources, contractor shall be held responsible. Any landscaping,

turf, or other natural resource damage shall be repaired, at no additional cost to the government, to the government standards as defined in "Maxwell Air Force Base Landscape Management Operational Instruction." Repair work shall be inspected and accepted by the Contracts office or TM/Contract Administrator. Any discrepancies shall be fixed before acceptance.

PART 5 – CONTACT INFORMATION

If at any time, contractor has environmental protection concerns or questions, first attempt to contact the Contracting Officer, who can contact the installation environmental office, 42 CES/CEIE. If Contracting Officer is not available, or in case of emergency, contractor may contact the environmental office at **334-953-5260**.

For immediate response in case of any chemical release or spill, contact the MAFB Fire Department at 334-953-9911. (From a MAFB installation phone, dial 911.)

INSTALLATION CERTIFICATION FOR CLEAN CONSTRUCTION DEBRIS TO BE REMOVED FROM THE CONSTRUCTION PROJECT SITE

As representative of Maxwell Air Force Base (insert name of installation),

I am authorized to certify, and hereby do so certify, that the construction debris to be removed from the Government project site at:

(describe project and list address, for example Building 1925, Shop Addition, Maxwell AFB, Montgomery, Alabama)

has been inspected and is free of all contamination, including but not limited to: lead paint, asbestos, PCBs, and pesticides.

CERTIFICATION:

Signed: _____ Date: _____

Printed Name, Rank or Grade, and Duty Title:

ORIGINAL OF THIS FORM MUST BE PROVIDED TO THE PM/TM

END OF SECTION



DEPARTMENT OF THE AIR FORCE
42D AIR BASE WING (AETC)
MAXWELL AIR FORCE BASE ALABAMA

12 Sep 22

MEMORANDUM FOR ALL MAXWELL AND GUNTER ANNEX PERSONNEL

FROM: 42 ABW/CC

SUBJECT: Maxwell AFB Environmental Commitment Statement

References: (a) AFI 32-7001, *Environmental Management*
(b) AFD 90-8, *Environment, Safety & and Occupational Health Management and Risk Management*
(c) DODI 4715.17, *Environmental Management Systems*

1. The Maxwell AFB community is strongly committed to conducting our mission in an environmentally safe manner, IAW AFI 32-7001, AFD 90-8 and DODI 4715.17. Our commitment goes beyond compliance and encompasses the integration of sound environmental management system (EMS) practices into our daily decisions and activities. During the EMS Planning Phase of the EMS Continuous Improvement Cycle, we will score the aspects and impacts of the installation's various processes and services. Significant aspects will be identified, and the resulting objectives and targets will be documented in Environmental Action Plans (EAPs). The status of the EAPs will be reviewed at least annually through the Cross Functional Team (CFT) and Senior Leadership. Our goal is to enhance mission performance by improving the management of environmental aspects of the mission.
2. In support of this EMS commitment statement, we must all follow the guidelines below:
 - a. Comply with all governing standards and environmental requirements.
 - b. Minimize environmental pollution/waste and promote waste reduction.
 - c. Integrate EMS information into all levels of management, to include appointing Unit Environmental Coordinators as members of the CFT.
 - d. Strive for continual improvement in our EMS performance.
3. Compliance with this commitment statement is the responsibility of every member of the Maxwell AFB and Gunter Annex communities, and I ask each of you to work aggressively to meet the intent of this commitment statement.
4. This EMS commitment statement will be publicized through several channels, including eDASH and CFT/UEC meetings. The commitment statement will be available to external parties through LeMay Center/PA, as determined by the CFT. If you have any questions, please contact the Installation Environmental Office at 334-953-5260.

RICHARDSON.RY
AN.E.1140810335
Digitally signed by
RICHARDSON.RYAN.E.1140810
335
Date: 2022.09.12 13:07:38 -0500

RYAN E. RICHARDSON, Colonel, USAF
Commander

CONTRACTOR'S HAZARDOUS MATERIAL QUESTIONNAIRE

1. Contractor's Company Name: _____
Name of Contractor: _____
Phone Number: _____
Fax Number: _____
Address: _____

2. Contract Number: _____

3. Date, time and location of pre-performance conference meeting.

4. Project: _____

5. Quality Assurance Personnel (QAP)/ Contracting Officer (CO)

_____ Phone# _____

6. Projected contract period: Start Date: _____ End Date: _____

7. Will contractor be using any hazardous material (HAZMAT) during this contract?

a) If the answer is NO to the above question, sign and date below.

_____	_____	_____
Contractor's Name (print)	Contractor's Signature	Date

b) If the answer is YES to the above question, sign and date below and complete item 8. Provide QAP/CO a chemical inventory and copies of all Material Safety Data Sheets (MSDS) 5 days prior to contract start date. Provide QAP/CO a monthly HAZMAT usage report (see Contractor's Environmental Reporting Entry Form, ESH-ESH-FM-003) during the contract period no later than 5 days after the end-of-each month.

_____	_____	_____
Contractor's Name (print)	Contractor's Signature	Date

8. Will the contractor be generating a potential waste or hazardous waste during the contract period? **(Yes/No)**
If YES, contact the base Hazardous Waste Manager at (334) 953-3892 for proper reporting and disposal procedures.

**The point-of-contact is the Hazardous Materials Management Office at
(334) 953-6417, Fax: (334) 953-4333.**

CONTRACTOR'S ENVIRONMENTAL REPORTING ENTRY FORM

1. Contract Number
2. Contractor Name
3. HAZMAT Storage Location: Building number & location/room in building. If multiple locations, please list. If stored off base, please indicate.
4. Date of reporting month (e.g. May 2021)
(Note: For items 5 – 10 List HAZMAT information in columns provided)
5. Product Name being reported (e.g. latex gloss paint, walnut wood stain) or locally assigned Material Stock Number (MSN)
6. Manufacturer of product
7. Application process/method: How product will be applied to process? (e.g. brush, roller, spray, other)
8. Unit of issue (e.g. 16 oz aerosol can, 3 oz tube, 5 gal pail)
9. Amount of material brought on base during reporting month (e.g. 3 cans, 2 tubes, 1 pail)
10. Amount of material used during reporting month

The Federal Government has targeted the following chemicals for reductions in use. This includes DOD contractor use. Please avoid the use of these items plus any confirmed human carcinogens, sensitizers, teratogens, mutagens or extremely toxic materials when possible.

Benzene
Cadmium (and compounds)
Carbon Tetrachloride
Chloroform (and compounds)
Chromium (and compounds)
Cyanides
Dichloromethane or Methylene Chloride
Lead (and compounds)
Mercury (and compounds)

Methyl Ethyl Ketone
Methyl Isobutyl Ketone
Nickel (and compounds)
Toluene
Trichloroethane
Trichloroethylene
Xylene
Tetrachloroethane
Perchloroethylene

CONTRACTOR'S ENVIRONMENTAL REPORTING ENTRY FORM

HAZMO Office, Bldg. 1060, Phone: (334) 953-6417, Fax: (334) 953-4333

Contractor's Signature: _____ Date: _____

1. Contract Number:	2. Contractor Name:	3. HAZMAT Storage Location(s):	4. Reporting Month & Year:

5. Product Name / MSN	6. Manufacturer	7. Application Method	8. Unit of Issue	9. Quantity Brought on Base	10. Quantity Used

See reverse side of form for instructions.
Copy form for additional space, if needed.

RECYCLING & LANDFILL REPORT

Please use the form below to report in TONS the amount of debris recycled and sent to the landfill. Provide a completed copy to Base Environmental (42 CES/CEIE).

Project #: _____

Building #: _____

Project Manager:_____

Company: _____

RECYCLING

MATERIAL RECYCLED

AMOUNT IN TONS

DATE _____

[illegible]

LANDFILL

MATERIAL SENT TO LANDFILL

AMOUNT IN TONS

DATE

[illegible]

**INSTALLATION CERTIFICATION FOR CLEAN CONSTRUCTION DEBRIS TO BE
REMOVED FROM THE CONSTRUCTION PROJECT SITE**

As representative of Maxwell Air Force Base (insert name of installation),

I am authorized to certify, and hereby do so certify, that the construction debris to be removed from the Government project site at:

(describe project and list address, for example Building 1925, Shop Addition, Maxwell AFB, Montgomery, Alabama)

has been inspected and is free of all contamination, including but not limited to: lead paint, asbestos, PCBs, and pesticides.

CERTIFICATION:

Signed: _____ Date: _____

Printed Name, Rank or Grade, and Duty Title:

ORIGINAL OF THIS FORM MUST BE PROVIDED TO THE PM/TM

SECTION 01 11 00

SUMMARY OF WORK
08/15, CHG 2: 08/21

PART 1 GENERAL

1.1 WORK COVERED BY CONTRACT DOCUMENTS

1.1.1 Project Description

The work covered by these specifications consists of furnishing all plant, labor, equipment and materials and performing all operations in connection with the PNQS-09-4491 REPAIR DINING FACILITY, BLDG 668 to include all areas as indicated on drawings and in strict accordance with these specifications and applicable drawings and subject to terms and conditions of the contract.

The work generally consists of the following:

- a. Renovating the entire building with the addition of new bathrooms, communications room and fire sprinkler room.
- b. New Kitchen layout.
- c. New Fire Sprinkler Layout / Plumbing / HVAC
- d. New Electrical / Communications / Fire Alarm
- e. New Civil and Landscaping
- f. Hazardous Materials abatement

1.1.2 Location

The work is located at Building 668, Maxwell Air Force Base, AL, approximately as indicated. The exact location will be shown by the Contracting Officer.

1.2 OCCUPANCY OF PREMISES

Building will **not** be occupied during performance of work under this Contract.

1.3 EXISTING WORK

In addition to FAR 52.236-9 Protection of Existing Vegetation, Structures, Equipment, Utilities, and Improvements:

- a. Remove or alter existing work in such a manner as to prevent injury or damage to any portions of the existing work which remain.
- b. Repair or replace portions of existing work which have been altered during construction operations to match existing or adjoining work, as approved by the Contracting Officer. At the completion of operations, existing work must be in a condition equal to or better than that which existed before new work started.

1.4 COORDINATION

The contractor shall coordinate work with the Technical Manager (TM)/Contract Administrator to avoid interference with necessary activities within and adjacent to the construction site. The Contractor shall coordinate the work of all trades to prevent any conflicts. The Contractor, before proceeding with the construction, shall resolve any conflicts of components.

1.5 SITE VISIT

Contractor is responsible for site investigation in accordance with contract clause entitled "Site Investigation and Conditions Affecting the Work" (FAR 52.236-3).

1.6 CONTRACT DRAWINGS AND SPECIFICATIONS

The Contractor must comply with the contract clause entitled "Specifications and Drawings for Construction" (FAR 52.236-21).

All drawings are diagrammatic and are intended to qualify the materials specified and indicate their intended relationship to each other. The drawings are not to be scaled, rather field conditions should dictate placement. The various scales used on the drawings may not allow the indications of all fittings, offsets, and accessories that may be required. The Contractor is to carefully investigate the conditions that would affect the work to be performed and shall arrange such work accordingly.

1.7 LOCATION OF UNDERGROUND UTILITIES

Prior to excavating for any purpose, the Contractor shall obtain an approved Construction Permit, AF Form 103 (dated July 1982), from the MSD/CE, 400 Cannon Street, Maxwell Air Force Base. The Government will determine what facilities are beneath the surfaces and discuss their locations with the Contractor prior to issuing the AF Form 103. Verify existing utility locations indicated on contract drawings, within area of work.

The purpose of this form is to give the Contractor clearance to excavate a given area, to protect the underground facilities, and to protect personnel from injury.

The Contractor is required to determine the exact location to be excavated in relation to the underground facilities prior to excavating. The AF Form 103 may note cable, pipe, etc., in the area; if this occurs, Contractor will be responsible for digging in such a manner so as not to damage the hidden facility. Contractor will place particular emphasis on the site inspection prior to proposing to determine which facilities are obviously in the area.

1.7.1 Notification Prior to Excavation

Notify the Contracting Officer at least 15 days prior to starting excavation work. After receipt of the approved AF Form 103, the Contractor will not perform any excavation work without specific approval by the Contracting Officer.

1.8 SALVAGE MATERIAL AND EQUIPMENT

No removed items will be reused in this contract unless specifically listed in these specifications and/or on the drawings. All removed equipment becomes the property of the Contractor unless noted otherwise.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

Not used.

-- End of Section --

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SECTION 01 14 00

WORK RESTRICTIONS
11/22, CHG 1: 02/23

PART 1

1.1 GENERAL

Government Approval is required for submittals. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

List of Contact Personnel

1.2 SPECIAL SCHEDULING REQUIREMENTS

- A. Schedule Of Work: The Contractor shall be responsible for establishing a schedule to meet construction time. Contractor shall prepare a work schedule on forms provided by Contracting Officer (CO)/Contract Administrator for schedule of work. Contractor shall have 516 calendar days to complete the work.
- B. Phasing Of Work: The Contractor shall procure all equipment and material to complete this project in order complete the work within the Construction Phase. The Contractor will have access to the site for construction activities.
- C. Permission to interrupt any Activity roads, railroads, or utility service must be requested in writing a minimum of 15 calendar days prior to the desired date of interruption.

CONTRACTOR ACCESS AND USE OF PREMISES

1.3

1.3.1 Activity Regulations

Ensure that Contractor personnel employed on the Activity become familiar with and obey Activity regulations including safety, fire, traffic and security regulations. Keep within the limits of the work and avenues of ingress and egress. Wear appropriate personal protective equipment (PPE) in designated areas. Do not enter any restricted areas unless required to do so and until cleared for such entry. Ensure all Contractor equipment, include delivery vehicles, are clearly identified with their company name.

The Contractor shall be responsible for the orderly handling of traffic through the work at all times during the life of the construction contract. This shall be accomplished in conformity with Sub article (d). "HANDLING OF TRAFFIC," of Article 104.04, "Sequence of Construction for Handling Traffic Through the Work and Construction and Maintenance of Detours," of Section 104, "SCOPE OF WORK," of the Alabama Highway Department "Standard Specifications for Highway Construction," 1992 Edition. In this specification, the word "Engineer" Shall be replaced with the words CO.

1.3.1.1 Subcontractors and Personnel Contacts

The Contractor shall notify 42 SFS/SPAI, Maxwell AFB AL, no later than 10 days after contract award a list of contact personnel. The notification shall include:

- a. Name, address, and telephone number of each company representative.
- b. The contract number and contracting agency (e.g., 42 CONS/PKC).
- c. The description of the work to be performed/construction project number.
- d. The location(s) of the construction work (i.e., street address or other description of the construction site).
- e. The date contract performance begins.
- f. Any updates to information previously provided under this paragraph.

The Contractor shall maintain a current listing of employees. The list shall include employee's name, social security number, and level of security clearance (if contract work involves unescorted entry to Air Force restricted or other sensitive areas designated by the installation commander). The list shall be validated and signed by the company Facility Security Officer (FSO) and provided to the TM/Contract Administrator, Maxwell AFB, AL, prior to the contract start date. Updated listing shall be provided when an employee's status or information changes.

1.3.1.2 No Smoking Policy

Contractors are advised that the Commander has placed restrictions on the smoking of tobacco products in AETC facilities. AFI 40-102, Tobacco Use in the Air Force, and its AETC supplement 1, outline the procedures used by the commander to control smoking in our facilities. Contractor employees and visitors are subject to the same restrictions as government personnel. Smoking is permitted only in designated smoking areas.

1.3.2 HEALTH STANDARDS

The following specified guidance is essential to maintaining compliance with the health standards on this base. This contract must adhere to all of the following.

1.3.2.1 Drinking Water:

- A. If a facility is to be constructed in which sources of drinking water are provided (sinks, water fountains, showers, etc.), the water lines must be flushed thoroughly prior to occupancy. BEE approval is required before the water is declared potable. If the contractor is required to test the interior water lines, provide BEE the documentation at two weeks prior to occupancy of the facility. If the contractor is not required to do bacteriological testing of the interior water lines, the BEE office should be contacted at least two weeks prior to occupancy so that we may schedule our testing of the system.
- B. If water mains are constructed or repaired, disinfection of the

lines must be conducted as stated in ANSI/AWWA C651-92, American Water Works Association for Disinfecting Water Mains prior to putting into service. Provide our office with a copy of the documentation that demonstrates compliance with the above requirements. We recommend coordination of the plan to disinfect water mains prior to construction to ensure that we agree with the disinfection and testing method.

1.3.2.2 Hazardous Materials

All hazardous chemicals (including paint, cleaning solutions, solvents and so on) used by the contractor must be registered with the Maxwell AFB Hazardous Material Manager, which can be contacted at 953-5260.

1.3.2.3 Radioactive Materials (RAM)

Air Force requirements for the management are listed in AFI 40-201, Management Radioactive Materials in the USAF. All contractors who intend to bring RAM (such as the materials in the soil density gauges, X-ray fluorescence meters, etc.) onto Maxwell AFB must first obtain written approval from the Base Radiation Safety Officer (RSO), in the Bioenvironmental Engineering (BEE) Flight 334-953-5848. To provide this approval, the RSO needs a written request no later than 30 days prior to initiating any work requiring radioactive material. The request must include the following information:

- A. A copy of your NRC license (or State license with a current NRC Fond 241) that authorizes your use of radioactive material on this installation.
- B. Training certificate(s) for individual(s) who will use the instrument on base.
- C. The most recent leak/wipe test for the instrument(s) that will be used on base.
- D. A signed document on company letterhead paper that includes:
 - 1. A brief description of your proposed activities including: instruments to be used and their purpose, the contract number and title under which you will work, location of the work (closest building number, annotated map, or similar identification), and anticipated start and end dates (with the understanding that actual days of use are difficult to specify in advance).
 - 2. The name, local address, and telephone number of both the responsible local representative and the RSO.
 - 3. Name and phone number of the Maxwell AFB inspector overseeing the project.
 - 4. An acknowledgement that the Maxwell AFB RSO can make periodic Checks to ensure contractor personnel follow radiation safety practices to prevent exposure to Air Force personnel and avoid contamination of government property as well as an understanding that the Maxwell AFB RSO has the authority to suspend any contractor operation believed to be unsafe.

1.3.2.4 Asbestos

No friable asbestos containing materials will be installed as a part of this contract. Spray application of asbestos or asbestos-containing materials to exposed walls, ceilings, ducts, columns, etc. is prohibited. In the event friable asbestos containing materials are encountered during "rip out" and demolition operations, the Contractor shall stop work in that area so that so not to disrupt the asbestos containing materials and notify the TM/Contract Administrator who will take appropriate action.

1.3.2.5 Asbestos/Lead-Based Paint Abatement

Contractors who will perform asbestos and or lead-based paint abatement work must comply with all OSHA regulations and be certified by Safe State of Alabama. In particular, after all visible debris has been removed and the abatement area has been appropriately decontaminated, the contractor must perform clearance sampling verifying the area is clean before re-occupancy can be allowed. BEE must review all clearance sample results prior to government acceptance of abatement areas as clean. Contractors can expedite this process by submitting copies of clearance results directly to the BEE for review.

1.3.3 Working Hours

The Contractor will perform all work during work hours between 6:00 A. M. and 5:00 P.M (normal working hours). The Contractor will not normally be permitted to work on weekends or on the following legal holidays (or the day the federal government observes these holidays) unless the work has coordinated such work with the TM/Contract Administrator at least 72 hours in advance:

- a. New Year's Day
- b. Martin Luther King, Jr.'s Birthday
- c. Washington's Birthday
- d. Memorial Day
- e. Juneteenth
- f. Independence Day
- g. Labor Day
- h. Columbus Day
- i. Veteran's Day
- j. Thanksgiving Day
- k. Christmas Day

1.3.4 Occupied Building

The Contractor shall be working around existing buildings which are occupied. Do not enter the buildings without prior approval of the Contracting Officer.

1.3.5 Utility Cutovers and Interruptions

- a. Make utility cutovers and interruptions after normal working hours or on Saturdays, Sundays, and Government holidays. Conform to procedures required in paragraph WORK OUTSIDE REGULAR HOURS.
- b. Ensure that new utility lines are complete, except for the connection, before interrupting existing service.
- c. Interruption to water, sanitary sewer, storm sewer, telephone service, electric service, air conditioning, heating, fire alarm, compressed air, and gas are considered utility cutovers .
- d. Operation of Station Utilities: The Contractor must not operate nor disturb the setting of control devices in the station utilities system, including water, sewer, electrical, and steam services. The Government will operate the control devices as required for normal conduct of the work. The Contractor must notify the Contracting Officer giving reasonable advance notice when such operation is required.

1.4 FIRE REGULATIONS

The Contractor shall comply with all aspects of the National Fire Protection Association (NFPA) publication 241, "Safeguarding Building Construction, Alteration and Demolition Operations; EM 385-1-1, Safety and Health Requirements Manual; and Maxwell AFB Instruction 32-2005, Fire Prevention and Protection During Construction, Alteration, Demolition, and Repair Operations.

1.5 PROTECTION OF GOVERNMENT PROPERTY AND PERSONNEL

1.5.1 Work Areas Included

- A. Construction site: Area or areas in which the work of the contract is accomplished or performed.
- B. Storage areas: Area or areas used for the storage of materials, devices, appliances, and equipment to be used in the work.
- C. Office and shed areas: Area or areas for placing or setting of temporary field office, tool sheds, or storage sheds.
- D. Transportation areas: Area or areas that are defined as streets, roads, driveways, parking areas, etc., paved, treated, and unpaved; area or areas not paved, such as grass plots or grass areas used for transportation purposes.

1.6 SECURITY REQUIREMENTS

1.6.1 PASS AND IDENTIFICATION

The Contractor shall obtain the following pass and identification items:

- A. DD Form 1172, "Application for Uniformed Services Identification Card" (AFI 36-3001 and AETCR 30-1). Forms shall be supplied by the Contracting Office Customer Service Station. The Contractor shall fill out the forms and take them to Pass and Identification, Building 502, 10 North Pine Street, Maxwell AFB.

- B. AETC Form 58, "Civilian Identification Card" (AETCR 30-1). Pass and Identification will issue this to each Contractor employee.
- C. AF Form 2219 (series), "Registered Vehicle Expiration Tab", (AFI 31-204), "Motor Vehicle Traffic Supervision" and DD Form 2220, "DOD Registered Vehicle and Installation Tab" (AFI 31-204). The Security Forces, Pass and Registration Section, Building 502, 10 North Pine Street (at the Bell Street entrance) will issue vehicle registration decals, upon proof of employment, insurance, ownership of vehicle, and a valid driver's license. A temporary decal will be issued if employment is for six months or less.
- D. AF Form 1199, USAF Restricted Area Badge, or a locally developed badge (if applicable).
- E. AF Form 75, Visitor/Vehicle Pass (AFI 31-204)
- F The Contractor shall retrieve all identification media, including vehicle decals from employees who depart for any reason before the contract expires (e.g., terminated for cause, retirement, etc.)

1.6.2 PHYSICAL SECURITY; KEY CONTROL; LOCK COMBINATIONS & CONTROLLED/RESTRICTED AREAS

1.6.2.1 Physical security

The Contractor shall be responsible for safeguarding all Government property and controlled forms provided for the Contractor's use. At the end of each work period, all Government facilities, equipment, and materials shall be secured. The Contractor shall also be responsible for the security of his own facilities, equipment, and material.

1.6.2.2 Key control.

The Contractor shall establish and implement methods of making sure all keys issued to the Contractor by the Government are not lost or misplaced and are not used by unauthorized persons. The following shall apply:

- A. The Contractor shall not duplicate any keys issued by the Government
- B. The Contractor shall immediately report any occurrences of lost or duplicated keys to the Government.
- C. In the event of lost or duplicated keys, the Contractor may be required, upon written direction of the Government, to re-key or replace the affected lock or locks without cost to the Government. The Government may, however, at its option, replace the affected lock or locks or perform re-keying and deduct the cost of such from payment due the Contractor. In the event a master key is lost or duplicated, the Government shall replace all locks and keys for that system and the total cost deducted from payment due the Contractor.
- D. The Contractor shall prohibit the use of Government issued keys by any persons other than the Contractor's employees and the opening of locked areas by Contractor employees to permit entrance of persons other than Contractor employees engaged in performance of contract work requirements in those areas.

1.6.2.3 Controlled/Restricted Areas.

The Contractor shall implement local Base procedures for entry to Air Force control/restricted areas where Contractor personnel will work.

1.6.2.4 Lock combinations.

The Contractor shall control access to all Government-provided lock combinations to preclude unauthorized entry.

1.6.3 OPERATING INSTRUCTION (OI)

If applicable, the Contractor shall develop an OI for internal circulation control, protection of resources, and regulated entry into Air Force controlled areas during normal, simulated, and actual emergency operations. The OI shall be coordinated through 42 SFS/SPAIR located at 130 W. Selfridge Street, Maxwell AFB, and shall be written in accordance with AFI 31-209 ("Air Force Resource Protection Program"), the local Base Operations Plan, and AFI 31-210 ("Anti-Terrorism Program").

1.6.4 REPORTING THREATS TO SECURITY

The Contractor shall comply with the requirements of AFI 71-101V1, "Counterintelligence Awareness and Briefing Program." Contractor personnel shall report to an appropriate authority any information or circumstances of which they are aware that may pose a threat to the security of DOD or Contractor personnel, resources, and classified or unclassified defense information. Contractor employees shall be briefed by their immediate supervisor upon initial on-base assignment.

1.6.5 WEAPONS, FIREARMS, AND AMMUNITION

Contractor employees are prohibited from possessing weapons, firearms, or ammunition on themselves or within Contractor-owned or privately owned vehicles while on Maxwell AFB or Gunter Annex.

PART 2 PRODUCTS

PART 3 EXECUTION

Not Used

-- End of Section --

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SECTION 01 20 00

PRICE AND PAYMENT PROCEDURES
11/20, CHG 3: 02/23

PART 1 GENERAL

1.1 SUBMITTALS

Government approval is required for submittals. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

CONTRACT PROGRESS SCHEDULE (AF FORM 3064);

G SD-03 Product Data

Weight Certificates CONTRACT COST BREAKDOWN

1.2

The Contractor must furnish within 30 days after the date of Notice to Proceed, and prior to the submission of its first partial payment estimate, a breakdown of its single job pay item or items which will be reviewed by the Contracting Officer as to propriety of distribution of the total cost to the various accounts. Any unbalanced items as between early and late payment items or other discrepancies will be revised by the Contracting Officer to agree with a reasonable cost of the work included in the various items. This Contract cost breakdown will then be utilized as the basis for progress payments to the Contractor.

1.3 CONTRACTOR'S INVOICE AND CONTRACT PERFORMANCE STATEMENT

1.3.1 WAWF-ELECTRONIC SUBMISSION OF INVOICE

In addition to the requirement of this local clause, the Contractor shall meet the requirements of the appropriate payment clauses in this contract when submitting payment requests.

Reference DFAR Clause 252.232-7003 "ELECTRONIC SUBMISSION OF PAYMENT REQUESTS."

Invoices shall be submitted and accepted using Wide Area Workflow (WAWF) web-based system at <https://wawf.eb.mil>. For information on WAWF including web-based training, visit the web-site and click on "About WAWF". The web-site also contains detailed instructions for setting up your computer to achieve the best results with the system. If you have additional questions contact the WAWF-RA Customer Helpdesk at (866) 618-5988, Option 2

1.3.1.1 Information Codes

The following information codes will be required to submit your invoices correctly through WAWF:

- a. SELECT TYPE OF INVOICE: Contract Specialist/Administrator select only one (1) of the following:
1. Invoice and Receiving Report (Combo) - (Creates two documents, an Invoice and a Receiving Report, within one data entry session (Combo). Creating both documents at the same time, rather than separately, is recommended.
 2. Construction Invoice - (Creates a Construction Payment Invoice from a contract for construction. Both an Inspector and a Contracting Officer must review and accept).
 3. Contract Number: Block 2 of the SF1449 Form (If this is a GSA Delivery Order award, enter the GSA NUMBER)
 4. Delivery Order: Block 4 of (Order Number) of SF1449 No Dashes - (if applicable)
 5. Pay DoDAAC: Block 16a (Payment will be made by) of SF1449 - Pay DoDAAC code is used to route documents to the Defense Finance Accounting office responsible for payment. The accounts payable mailing address can be located in Block 18a of SF1449. You can easily access payment information using the DFAS web site at <http://www.dod.mil/dfas>. Your contract/purchase order number or invoice will be required to inquire status of your payment.
 6. Issue by DoDAAC: Block 9 (Issued by) of SF1449. Contracting office that issued your contract - WAWF uses the code to route the document to the base.
 7. Admin DoDAAC: Block 16 (Administered by) of SF1449)
 8. Ship-To Code: Block 15 (Deliver To) of SF1449 - This is a crucial piece of information. It will be different for almost every contract issued.
 9. Ship-From Code: Not a required field for Air Force contracts.
 10. Inspected by DoDAAC: Block 15 (Deliver to) of SF1449 - If an inspection is called for in the document, then you must provide the DoDAAC/Ext this code identifies the inspector.
 11. Service Acceptor: Block 15 (Deliver to) of SF1449 - It is used to route documents to receiving service acceptor in WAWF.
 12. LPO DoDAAC/Ext: Not a required field for Air Force contracts.

1.3.2 ADDITIONAL E-MAIL NOTIFICATIONS:

The VENDOR and the DFAS Office will automatically receive a notice; after clicking SUBMIT WAWF will prompt for additional email submissions. The following E-Mail addresses MUST be input in order to prevent delays in processing:

Receiver/Acceptor: XXXXXXXXXX@us.af.mil

Contract Specialist: XXXXXXXXXX@us.af.mil

Repair Dining Facility, Bldg 668
Maxwell AFB, Alabama

MAFB-PNQS-09-4491
PHJA/2223US

Contracting Officer: XXXXXXXXX@us.af.mil

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

-- End of Section --

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1.8 SUPERVISION

1.8.1 Superintendent Qualifications

Provide project superintendent with a minimum of [10][_____] years experience in construction with at least [5][_____] of those years as a superintendent on projects similar in size and complexity. The individual must be familiar with the requirements of EM 385-1-1 and have experience in the areas of hazard identification and safety compliance. The individual must be capable of interpreting a critical path schedule and construction drawings. The qualification requirements for the alternate superintendent are the same as for the project superintendent. The Contracting Officer may request proof of the superintendent's qualifications at any point in the project if the performance of the superintendent is in question.

For projects where the superintendent is permitted to also serve as the Quality Control (QC) Manager as established in Section 01 45 00.00 10 QUALITY CONTROL, the superintendent must have qualifications in accordance with that section.

1.8.2 Minimum Communication Requirements

Have at least one qualified superintendent, or competent alternate, capable of reading, writing, and conversing fluently in the English language, on the job-site at all times during the performance of Contract work. In addition, if a Quality Control (QC) representative is required on the Contract, then that individual must also have fluent English communication skills.

1.8.3 Duties

The project superintendent is primarily responsible for managing subcontractors and coordinating day-to-day production and schedule adherence on the project. The superintendent is required to attend Red Zone meetings, partnering meetings, and quality control meetings. The superintendent or qualified alternative must be on-site at all times during the performance of this contract until the work is completed and accepted.

1.8.4 Non-Compliance Actions

The Project Superintendent is subject to removal by the Contracting Officer for non-compliance with requirements specified in the contract and for failure to manage the project to ensure timely completion. Furthermore, the Contracting Officer may issue an order stopping all or part of the work until satisfactory corrective action has been taken. No part of the time lost due to such stop orders is acceptable as the subject of claim for extension of time for excess costs or damages by the Contractor.

1.9 CONDUCT OF WORK

The Contractor shall conduct work so the Government property and personnel, other personnel, and work areas shall be protected at all times from inconvenience, damage of any nature, or injury caused by this work until completion of the contract.

1.10 PRECONSTRUCTION CONFERENCE

Immediately after award, prior to commencing any work at the site, coordinate with the Contracting Officer a time and place to meet for the Preconstruction Conference. The conference must take place within [35] [_____] calendar days after award of the contract, but prior to commencement of any work at the site. The purpose of this conference is to discuss and develop a mutual understanding of the administrative requirements of the Contract including but not limited to: daily reporting, invoicing, value engineering, safety, base-access, outage requests, hot work permits, schedule requirements, quality control, schedule of prices or earned value report, shop drawings, submittals, cybersecurity, prosecution of the work, government acceptance, final inspections and contract close-out. Contractor must present and discuss their basic approach to scheduling the construction work and any required phasing.

1.10.1 Attendees

Contractor attendees must include the Project Manager, Superintendent, Site Safety and Health Officer (SSHO), Quality Control Manager and major subcontractors.

1.11 FACILITY TURNOVER PLANNING MEETINGS (Red Zone Meetings)

Meet with the Government to identify strategies to ensure the project is carried to expeditious closure and turnover to the Client. Start planning the turnover process at the Pre-Construction Conference meeting with a discussion of the Red Zone process and convene at regularly scheduled NRZ Meetings beginning at approximately 75 percent of project completion. Include the following in the facility Turnover effort:

1.11.1 Red Zone Checklist

- a. Contracting Officer's Technical Representative (COTR) will provide the Contractor a copy of the Red Zone Checklist template.
- b. Prior to 75 percent completion, modify the Red Zone Checklist template by adding or deleting critical activities applicable to the project and assign planned completion dates for each activity. Submit the modified Red Zone Checklist to the Contracting Officer. The Contracting Officer may request additional activities be added to the Red Zone Checklist at any time as necessary.

1.11.2 Meetings

- a. Conduct regular Red Zone Meetings beginning at approximately 75 percent project completion, or three to six months prior to Beneficial Occupancy Date (BOD), whichever comes first.
- b. The Contracting Officer will establish the frequency of the meetings, which is expected to increase as the project completion draws nearer.

At the beginning, Red Zone meetings may be every two weeks then increase to weekly towards the final month of the project.

- c. Using the Red Zone Checklist as a Plan of Action and Milestones (POAM) and basis for discussion, review upcoming critical activities and strategies to ensure work is completed on time.
- d. During the Red Zone Meetings discuss with the COTR any upcoming activities that require Government involvement.
- e. Maintain the Red Zone Checklist by documenting the actual completion dates as work is completed and update the Red Zone Checklist with revised planned completion dates as necessary to match progress. Distribute copies of the current Red Zone Checklist to attendees at each Red Zone Meeting.

1.12 MOBILIZATION

Contractor shall mobilize to the jobsite within [60 calendar days after contract award] [30 calendar days of final site or building design approval]. Mobilize is defined as having equipment AND having a physical presence of at least one person from the contractor's team on the jobsite.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

-- End of Section --

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SECTION 01 33 00 SUBMITTAL PROCEDURES
July 7, 2022

PART 1 GENERAL

1.01 SUMMARY (Not Applicable)

1.02 REFERENCES (Not Applicable)

1.03 SUBMITTAL CLASSIFICATION

1.03.1 Submittals are classified as follows:

1.03.1.1 Contracting Officer (CO) Approval: CO approval is required for extensions of design, critical materials, deviations, equipment whose compatibility with the entire system must be checked. Within the terms of the Contract Clause entitled "Specifications and Drawings for Construction", they are considered to be "shop drawings."

1.03.1.2 For Information Only: All submittals not requiring the Government approval will be "For information only" (FIO). They are not considered to be "shop drawings" within the terms of the Contract Clause referred to above.

1.04 APPROVED SUBMITTALS:

The approval of submittals by the CO/Contract Administrator shall not be construed as a check, but will indicate only that the general method of construction, materials, detailing and other information are satisfactory. Approval will not relieve the Contractor of the responsibility for any error that may exist because the Contractor is responsible for the dimensions and design of adequate connections, details and satisfactory construction of all work. After submittals have been approved by the CO/Contract Administrator, no resubmittals for the purpose of substituting materials or equipment will be given consideration unless accompanied by an explanation as to why a substitution is necessary.

1.05 DISAPPROVED SUBMITTALS:

The Contractor shall make all corrections required by the CO/Contract Administrator and promptly furnish a corrected submittal in the form and number of copies as specified for the initial submittal. If the Contractor considers any correction indicated on the submittals to constitute a change to the contract, notice as required under the Contract Clause entitled "Changes" shall be given promptly to the CO.

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTIONS

3.01 GENERAL:

The Contractor shall submit all items listed on the Submittal Register (AF Form 66 Schedule of Material Submittals, or equivalent) or specified in the other sections of these specifications. The CO may request submittals in addition to those listed when deemed necessary to adequately describe the work covered in the respective sections. Units of weights and measures used on all submittals shall be the same used in

the contract drawings. Unless noted otherwise by the CO/Contract Administrator, submittals shall be made in three (3) hard copies as shown on the Submittal Register or submitted electronically. Each submittal shall be complete and in sufficient detail to allow ready determination of compliance with contract requirements. Prior to submittal, all items shall be checked and approved and each respective transmittal form or material approval submittal (AF Form 3000, Material Approval Submittal) shall be stamped, signed and dated by the Contractor certifying that the accompanying submittal complies with the contract requirements. Submittals shall include line number of item from Government-prepared Submittal Register. Proposed deviations from the contract requirements shall be clearly identified. Submittals shall include items such as: Contractor's, manufacturer's, or fabricator's drawings; descriptive literature including catalog cuts, diagrams, operating charts or curves; test reports; test cylinders; samples; O&M manuals including parts list; certifications; warranties and other such required submittals. Submittals requiring approval by the CO/Contract Administrator shall be scheduled and made prior to the acquisition of the material or equipment covered thereby.

3.02 SUBMITTAL REGISTER (AF FORM 66 Schedule of Material Submittals):

A Submittal Register on AF Form 66, Schedule of Material Submittals, shall be made available to the Contractor upon issuance of Notice to Proceed. Within ten working days, the Contractor shall meet with the Technical Manager (TM)/Contract Administrator to jointly review the contractor-prepared Submittal Register. The Contractor shall be responsible for providing all items listed on the Submittal Register in accordance with the scheduled submittal dates. Allowance shall be made for rejected submittals.

3.03 SCHEDULING:

Submittals covering component items forming a system or items that are interrelated shall be scheduled to be coordinated and submitted concurrently. Certifications to be submitted with the pertinent drawings shall be so scheduled. The Contractor shall take special care to timely schedule the submittal date required for long lead-time items and shall allow 10 working days for review action by the Contract Administrator on all submittals except as noted below. No delays damages or time extensions will be allowed for time lost in late submittals. All submittals will be made on AF Form 3000, Material Approval Submittal as specified below.

3.04 TRANSMITTAL FORM (AF FORM 3000, Material Approval Submittal):

AF FORM 3000, Material Approval Submittal shall be used for submitting both Government approved and information only submittals in accordance with the instructions on the reverse side of the form. These forms will be furnished to the Contractor by the Contract Administrator. This form shall be properly completed by filling out all the heading blank spaces and identifying each item submitted. Special care will be exercised to ensure proper listing of the specification paragraph and/or sheet number of the contract drawings pertinent to the data submitted for each item.

3.05 CONTROL OF SUBMITTALS:

The Contractor shall carefully control his procurement operations to ensure that each individual submittal is made on or before the Contractor scheduled submittal date shown on the approved "**Submittal Register.**"

3.06 SUBMITTALS:

Upon completion of the review of a submittal requiring approval, the submittal will be identified as having received approval or disapproval by being so noted on AF FORM 3000, Material Approval

Submittal, by the CO/Contract Administrator. Such submittals shall be made in accordance with the Construction Contract Clause entitled "Specifications and Drawings for Construction" and the following: unless otherwise noted on the Submittal Register, three (3) prints of all drawings; or, if catalog cuts, printed specifications or similar publications are used as submittals, three (3) original copies shall be submitted. One corrected copy shall be returned to the Contractor. In cases where "trade names or equal" specifications are used, any equal substitution by the Contractor will be considered a deviation and will require approval. Any submittal requesting a deviation shall be considered as one requiring "approval" action. Payment for materials incorporated into the work will not be allowed if required approvals have not been obtained. Upon completion of review of submittals requiring approval, the submittals will be identified as having received approval or disapproval by being so noted on AF FORM 3000, Material Approval Submittal.

3.07 FIO SUBMITTALS:

All other submittals are considered to be FIO submittals and may be subject to review action by the CO/Contract Administrator or may be simply receipt acknowledged. Any submittal "For Information Only" shall be clearly marked "FIO". Normally FIO submittals will not be returned. Approval is not required for information only submittals. The CO reserves the right to require the Contractor to resubmit any item found not to comply with the contract. This does not relieve the Contractor from the obligation to furnish material conforming to the plans and specifications and will not prevent the CO from requiring removal and replacement if nonconforming material is incorporated in the work. This also does not relieve the Contractor of the requirement to furnish samples for testing by an independent laboratory or check testing by the CO/Contract Administrator, in those instances where the technical specifications so prescribe. It shall be the Contractor's responsibility to ensure that the materials and/or equipment covered by that submittal meets the contract requirements. Any such FIO submittal found to contain errors or omissions shall be resubmitted as one requiring "approval" action. All FIO submittals shall be made in triplicate unless otherwise specified.

END OF SECTION 01305

[illegible]

INSTRUCTIONS TO CONTRACTORS

1. The term "material" is defined as articles, supplies, raw materials, equipment, parts, components, and end items that are to be incorporated into the work required by the
2. This form is to be used by contractors for submitting Shop Drawings, Equipment Data, Manufacturer's Literature and Certificates and samples of Materials to the Government for approval in accordance with the provisions of this contract. Unless otherwise specified, it is to be prepared in 4 copies, signed, and provided to the contracting officer with appropriate attachments.
3. Item(s) to be approved will be clearly tabbed or identified. Data pertaining to item(s) to be approved will be clearly identified or tabbed, particularly where documents are voluminous, in order to properly evaluate the materials or articles to be incorporated in the work. Each attachment will be numbered to correspond with the item number shown on the face of this form.
4. Requests submitted shall be numbered consecutively, by contract, in the space entitled "Submission No.". This number, in addition to the Contract No., will be used to identify each Material Approval Submittal. Resubmissions will be indicated in the appropriate block and the insertion of previous submission number and data in addition to a new submission number. A single submission should be used for all work of a section of the specifications, but in NO instance should the submission include work for more than one (1) contract. Submittals requiring priority handling will be submitted by separate submittal using the form and so marked across the face of the form.
5. This Material Approval Submittal is not valid unless it is signed by the contracting officer. This approval is required as called for by the contracting officer under the terms of this contract.

SECTION 01 35 33

ENVIRONMENTAL PROCEDURES

08/22

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.1200	Hazard Communication
40 CFR 261	Identification and Listing of Hazardous Waste
40 CFR 261.7	Residues of Hazardous Waste in Empty Containers
40 CFR 273	Standards for Universal Waste Management
49 CFR 171	General Information, Regulations, and Definitions
49 CFR 172	Hazardous Materials Table, Special Provisions, Hazardous Materials Communications, Emergency Response Information, and Training Requirements
49 CFR 173	Shippers - General Requirements for Shipments and Packagings

WASHINGTON STATE ADMINISTRATIVE CODE (WAC)

WAC-173-303-573	Standards for Universal Waste Management
WAC-173-303-573(2)	Standards for Universal Waste Management - Batteries
WAC-173-303-573(3)	Standards for Universal Waste Management - Mercury-containing Equipment
WAC-173-303-573(5)	Standards for Universal Waste Management - Lamps

1.2 ACRONYMS

ADEM - Alabama Department of Environmental Management
CAA - Clean Air Act

CO - Contracting Officer

CERCLA - Comprehensive Environmental Response, Compensation and Liability Act

CWA - Clean Water Act

EPA - Environmental Protection Agency

MAFB - Maxwell Air Force Base and Gunter Annex. Throughout this environmental protection section, MAFB (including Gunter Annex) may commonly be referred to as the base or installation.

Media - Any soil, water, or air that is moved, disturbed, or released from a site

OSHA - Occupational Safety and Health Administration

TM - Technical Manager

RCRA - Resource Conservation and Recovery Act

SDWA - Safe Drinking Water Act TSCA - Toxic Substances Control Act

42 CES/CEIE - Maxwell Air Force Base Civil Engineering Squadron, Environmental Section. Throughout this environmental protection section, this office will commonly be referred to as the "installation environmental office."

The terms hazardous, waste, pollutant, contaminant, and substance have the same meanings and usage here as they commonly do in the CAA, CERCLA, RCRA, SDWA, and TSCA.

1.3 DEFINITIONS

1.3.1 Class I and II Ozone Depleting Substance (ODS)

Class I ODS is defined in Section 602(a) of The Clean Air Act. A list of Class I ODS can be found on the EPA website at the following weblink.
<https://www.epa.gov/ozone-layer-protection/ozone-depleting-substances>.

Class II ODS is defined in Section 602(s) of The Clean Air Act. A list of Class II ODS can be found on the EPA website at the following weblink.
<https://www.epa.gov/ozone-layer-protection/ozone-depleting-substances>.

1.3.2 Contractor Generated Hazardous Waste

Contractor generated hazardous waste is materials that, if abandoned or disposed of, may meet the definition of a hazardous waste. These waste streams would typically consist of material brought on site by the Contractor to execute work, but are not fully consumed during the course of construction. Examples include, but are not limited to, excess paint thinners (i.e., methyl ethyl ketone, toluene), waste thinners, excess paints, excess solvents, waste solvents, excess pesticides, and contaminated pesticide equipment rinse water.

1.3.3 Electronics Waste

Electronics waste is discarded electronic devices intended for salvage, recycling, or disposal.

1.3.4 Environmental Pollution and Damage

Environmental pollution and damage is the presence of chemical, physical, or biological elements or agents which adversely affect human health or welfare; unfavorably alter ecological balances of importance to human life; affect other species of importance to humankind; or degrade the environment aesthetically, culturally or historically.

1.3.5 Environmental Protection

Environmental protection is the prevention/control of pollution and habitat disruption that may occur to the environment during construction. The control of environmental pollution and damage requires consideration of land, water, and air; biological and cultural resources; and includes management of visual aesthetics; noise; solid, chemical, gaseous, and liquid waste; radiant energy and radioactive material as well as other pollutants.

1.3.6 Hazardous Debris

As defined in paragraph SOLID WASTE, debris that contains listed hazardous waste (either on the debris surface, or in its interstices, such as pore structure) in accordance with 40 CFR 261. Hazardous debris also includes debris that exhibits a characteristic of hazardous waste in accordance with 40 CFR 261.

1.3.7 Hazardous Materials

Hazardous material is any material that: Is defined in 49 CFR 171, listed in 49 CFR 172, regulated as a hazardous material in accordance with 49 CFR 173; or requires a Safety Data Sheet (SDS) in accordance with 29 CFR 1910.1200; or during end use, treatment, handling, packaging, storage, transportation, or disposal meets or has components that meet or have potential to meet the definition of a hazardous waste as defined by 40 CFR 261 Subparts A, B, C, or D. Designation of a material by this definition, when separately regulated or controlled by other sections or directives, does not eliminate the need for adherence to that hazard-specific guidance which takes precedence over this section for "control" purposes. Such material includes ammunition, weapons, explosive actuated devices, propellants, pyrotechnics, chemical and biological warfare materials, medical and pharmaceutical supplies, medical waste and infectious materials, bulk fuels, radioactive materials, and other materials such as asbestos, mercury, and polychlorinated biphenyls (PCBs).

1.3.8 Hazardous Waste

Hazardous Waste is any material that meets the definition of a solid waste and exhibits a hazardous characteristic (ignitability, corrosivity, reactivity, or toxicity) as specified in 40 CFR 261, Subpart C, or contains a listed hazardous waste as identified in 40 CFR 261, Subpart D, or meets a state, local, or host nation definition of a hazardous waste.

1.3.9 Land Application

Land Application means spreading or spraying discharge water at a rate that allows the water to percolate into the soil. No sheeting action, soil erosion, discharge into storm sewers, discharge into defined drainage areas, or discharge into the "waters of the United States" must occur. Comply with federal, state, and local laws and regulations.

1.3.10 Municipal Separate Storm Sewer System (MS4) Permit

MS4 permits are those held by municipalities or installations to obtain NPDES permit coverage for their stormwater discharges.

1.3.11 National Pollutant Discharge Elimination System (NPDES)

The NPDES permit program controls water pollution by regulating point sources that discharge pollutants into waters of the United States.

1.3.12 Oily Waste

Oily waste are those materials that are, or were, mixed with Petroleum, Oils, and Lubricants (POLs) and have become separated from that POLs. Oily wastes also means materials, including wastewaters, centrifuge solids, filter residues or sludges, bottom sediments, tank bottoms, and sorbents which have come into contact with and have been contaminated by, POLs and may be appropriately tested and discarded in a manner which is in compliance with other state and local requirements.

This definition includes materials such as oily rags, "kitty litter" sorbent clay and organic sorbent material. These materials may be land filled provided that: It is not prohibited in other state regulations or local ordinances; the amount generated is "de minimus" (a small amount); it is the result of minor leaks or spills resulting from normal process operations; and free-flowing oil has been removed to the practicable extent possible. Large quantities of this material, generated as a result of a major spill or in lieu of proper maintenance of the processing equipment, are a solid waste. As a solid waste, perform a hazardous waste determination prior to disposal. As this can be an expensive process, it is recommended that this type of waste be minimized through good housekeeping practices and employee education.

1.3.13 Pesticide

Pesticide is any substance or mixture of substances intended for preventing, destroying, repelling, or mitigating any pest, or intended for use as a plant regulator, defoliant or desiccant.

1.3.14 Pesticide Treatment Plan

A plan for the prevention, monitoring, and control to eliminate pest infestation.

1.3.15 Pests

Pests are arthropods, birds, rodents, nematodes, fungi, bacteria, viruses, algae, snails, marine borers, snakes, weeds and other organisms (except for human or animal disease-causing organisms) that adversely affect readiness, military operations, or the well-being of personnel and animals; attack or damage real property, supplies, equipment, or vegetation; or are otherwise undesirable.

1.3.16 Project Pesticide Coordinator

The Project Pesticide Coordinator (PPC) is an individual who resides at a Civil Works Project office and who is responsible overseeing of pesticide application on project grounds.

1.3.17 Regulated Waste

Regulated waste are solid wastes that have specific additional federal, state, or local controls for handling, storage, or disposal.

1.3.18 Sediment

Sediment is soil and other debris that have eroded and have been transported by runoff water or wind.

1.3.19 Solid Waste

Solid waste is a solid, liquid, semi-solid or contained gaseous waste. A solid waste can be a hazardous waste, non-hazardous waste, or non-Resource Conservation and Recovery Act (RCRA) regulated waste. Types of solid waste typically generated at construction sites may include:

1.3.19.1 Debris

Debris is non-hazardous solid material generated during the construction, demolition, or renovation of a structure that exceeds 2.5-inch particle size that is: a manufactured object; plant or animal matter; or natural geologic material (for example, cobbles and boulders), broken or removed concrete, masonry, and rock asphalt paving; ceramics; roofing paper and shingles. Inert materials [may][may not] be reinforced with or contain ferrous wire, rods, accessories and weldments. A mixture of debris and other material such as soil or sludge is also subject to regulation as debris if the mixture is comprised primarily of debris by volume, based on visual inspection.

1.3.19.2 Green Waste

Green waste is the vegetative matter from landscaping, land clearing and grubbing, including, but not limited to, grass, bushes, scrubs, small trees and saplings, tree stumps and plant roots. Marketable trees, grasses and plants that are indicated to remain, be re-located, or be re-used are not included.

1.3.19.3 Material Not Regulated As Solid Waste

Material not regulated as solid waste is nuclear source or byproduct materials regulated under the Federal Atomic Energy Act of 1954 as amended; suspended or dissolved materials in domestic sewage effluent or irrigation return flows, or other regulated point source discharges; regulated air emissions; and fluids or wastes associated with natural gas or crude oil exploration or production.

1.3.19.4 Non-Hazardous Waste

Non-hazardous waste is waste that is excluded from, or does not meet, hazardous waste criteria in accordance with 40 CFR 261.

1.3.19.5 Recyclables

Recyclables are materials, equipment and assemblies such as doors, windows, door and window frames, plumbing fixtures, glazing and mirrors that are recovered and sold as recyclable, [wiring,] [insulated/non-insulated copper wire cable,] [wire rope,] and structural

components. It also includes commercial-grade refrigeration equipment with Freon removed, household appliances where the basic material content is metal, clean polyethylene terephthalate bottles, cooking oil, used fuel oil, textiles, high-grade paper products and corrugated cardboard, stackable pallets in good condition, clean crating material, and clean rubber/vehicle tires. Metal meeting the definition of lead contaminated or lead based paint contaminated [may][may not] be included as recyclable if sold to a scrap metal company. Paint cans that meet the definition of empty containers in accordance with 40 CFR 261.7 may be included as recyclable if sold to a scrap metal company.

1.3.19.6 Surplus Soil

Surplus soil is existing soil that is in excess of what is required for this work, including aggregates intended, but not used, for on-site mixing of concrete, mortars, and paving. Contaminated soil meeting the definition of hazardous material or hazardous waste is not included and must be managed in accordance with paragraph HAZARDOUS MATERIAL MANAGEMENT.

1.3.19.7 Scrap Metal

This includes scrap and excess ferrous and non-ferrous metals such as reinforcing steel, structural shapes, pipe, and wire that are recovered or collected and disposed of as scrap. Scrap metal meeting the definition of hazardous material or hazardous waste is not included.

1.3.19.8 Wood

Wood is dimension and non-dimension lumber, plywood, chipboard, hardboard. Treated or painted wood that meets the definition of lead contaminated or lead based contaminated paint is not included. Treated wood includes, but is not limited to, lumber, utility poles, crossties, and other wood products with chemical treatment.

1.3.20 Surface Discharge

Surface discharge means discharge of water into drainage ditches, storm sewers, or creeks meeting the definition of "waters of the United States". Surface discharges from construction sites are discrete, identifiable sources and require a permit from the governing agency. Comply with federal, state, and local laws and regulations.

1.3.21 Wastewater

Wastewater is the used water and solids that flow through a sanitary sewer to a treatment plant.

1.3.21.1 Stormwater

Stormwater is any precipitation in an urban or suburban area that does not evaporate or soak into the ground, but instead collects and flows into storm drains, rivers, and streams.

1.3.22 Waters of the United States

Waters of the United States means Federally jurisdictional waters, including wetlands, that are subject to regulation under Section 404 of the Clean Water Act or navigable waters, as defined under the Rivers and Harbors Act.

1.3.23 Wetlands

Wetlands are those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions.

1.3.24 Universal Waste

The universal waste regulations streamline collection requirements for certain hazardous wastes in the following categories: batteries, pesticides, mercury-containing equipment (for example, thermostats), and lamps (for example, fluorescent bulbs). The rule is designed to reduce hazardous waste in the municipal solid waste (MSW) stream by making it easier for universal waste handlers to collect these items and send them for recycling or proper disposal. These regulations can be found at [40 CFR 273](#).

1.3.25 Location Specific Universal Waste

Any of the following dangerous waste that are subject to the universal waste requirements of [WAC-173-303-573](#): Batteries as described in [WAC-173-303-573\(2\)](#); Lamps as described in [WAC-173-303-573\(5\)](#); Mercury-containing equipment as described in [WAC-173-303-573\(3\)](#).

1.4 SUBMITTALS

Government approval is required for submittals. Submit the following in accordance with Section [01 33 00](#) SUBMITTAL PROCEDURES:

[SD-01 Preconstruction Submittals](#)

[Solid Waste Management Permit](#)

[SD-06 Test Reports](#)

[Monthly Solid Waste Disposal Report](#)

[SD-11 Closeout Submittals](#)

[Solid Waste Management Permit](#)

1.5 ENVIRONMENTAL PROTECTION REQUIREMENTS

Provide and maintain, during the life of the contract, environmental protection as defined. These requirements are in addition to any environmental protection requirements elsewhere in these specifications. For the purpose of this specification, environmental pollution is defined as the presence of chemical, physical, or biological elements or agents, not naturally occurring at the site, which adversely affect human health or welfare; unfavorably alter ecological balances; negatively affect plant or animal species; or degrade the utility of the environment for aesthetic and recreational purposes. The control of environmental pollution by the contractor requires consideration of air, water, and land, and involves noise control, solid waste management and management of radiant energy and radioactive materials, as well as other pollutants. This section also requires the protection of natural, cultural and historic resources.

Tests and procedures assessing whether construction operations comply with Applicable Environmental Laws may be required. Analytical work must be performed by qualified laboratories; and where required by law, the laboratories must be certified.

1.6 SPECIAL ENVIRONMENTAL REQUIREMENTS

1.6.1 CONTRACTOR'S GENERAL ENVIRONMENTAL COMPLIANCE OBLIGATIONS

1.6.1.1 Compliance Requirements

Work under this contract is to be performed on a government facility. All environmental rules applying to contractor operations elsewhere shall also apply on the government facility. Contractor (and any of their additional contractors, agents or representatives) shall comply with all applicable Federal, State, and local laws and regulations providing for environmental protection and pollution control and abatement. These include but are not limited to: the Clean Air Act, Clean Water Act, Resource Conservation and Recovery Act, Comprehensive Environmental Response, Compensation and Liability Act, Toxic Substances Control Act, Federal Insecticide Fungicide and Rodenticide Act, Coastal Zone Management Act, Endangered Species Act, Migratory Bird Treaty Act, National Historic Preservation Act, Archeological Resources Protection Act, Safe Drinking Water Act, Emergency Planning and Community Right-to-Know Act, Oil Pollution Act, and Pollution Prevention Act. Contractor has the duty to determine for himself/herself where such laws and regulations apply. Although the contractor may request assistance from the TM/Contract Administrator or the installation environmental office in delineating applicable environmental laws and regulations, contractor has an independent responsibility to make its own determination and to do so in a timely fashion. Environmental Management System (EMS) significant aspect is Hazardous Waste Compliance. Please ensure all personnel are aware of applicable RCRA requirements and have reviewed the Commander's Policy at the end of this section.

1.6.1.2 Compliance Program

Contractors are responsible to implement their own environmental compliance programs, to ensure that individuals working at the site are properly trained and aware of potential hazards and proper operating procedures, and to ensure that all personnel follow the guidelines of OSHA, EPA, ADEM, and the Air Force's policies, in addition to any guidelines of the jurisdiction(s) in which the operations will be performed. Compliance with the provisions of this section by lower tier contractors will be the responsibility of the contractor.

1.6.1.3 Notification

The Contract Administrator will notify the Contractor in writing of any non-compliance with environmental provisions and the action to be taken. The Contractor shall, after receipt of such notice, immediately take corrective action. If the Contractor fails or refuses to comply promptly, the Contract Administrator may issue an order stopping all or part of the work until satisfactory corrective action has been taken. No part of the time lost due to any such stop orders shall be made the subject of a claim for extension of time or for excess costs or damages by the Contractor unless it was later determined that the Contractor was in compliance.

1.6.1.4 Maintenance of Pollution Control Facilities During Construction

During the life of this contract, the Contractor shall maintain all facilities constructed for pollution control under this contract as long as the operations creating the particular pollutant are being carried out or until the material concerned has become stabilized to the extent that pollution is no longer being created.

1.7 QUALITY ASSURANCE

1.7.1 Non-Compliance Notifications

The Contracting Officer will notify the Contractor in writing of any observed noncompliance with federal, state or local environmental laws or regulations, permits, and other elements of the Contractor's EPP. After receipt of such notice, inform the Contracting Officer of the proposed corrective action and take such action when approved by the Contracting Officer. The Contracting Officer may issue an order stopping all or part of the work until satisfactory corrective action has been taken. FAR 52.242-14 Suspension of Work provides that a suspension, delay, or interruption of work due to the fault or negligence of the Contractor allows for no adjustments to the contract for time extensions or equitable adjustments. In addition to a suspension of work, the Contracting Officer may use additional authorities under the contract or law.

1.7.1.1 FINES OR PENALTIES FOR ENVIRONMENTAL NON-COMPLIANCE

The contractor shall be responsible for paying any fines or penalties assessed against the Government for violations of environmental laws or regulations resulting from acts or omissions of the contractor or its employees, contractors, or agents. This obligation is in addition to any fines or penalties that may be assessed against the contractor for the same conduct. Contractor shall either reimburse these fines or penalties through the appropriate Contract Administrator, or with the consent of the Contracting office and installation environmental office, the Contractor shall pay such fines or penalties directly to the regulatory agency or agencies concerned.

- A. Pollution Reporting: No hazardous material can be released into the environment (ground, water, air) without prior approval of the contractor. In the event of an accidental release of a hazardous material to any of these medias, the contractor will be notified immediately. The contractor will supply the means to properly prevent/contain and dispose of an accidental release in accordance with all applicable Federal, State, and Local regulations. All costs incurred by the contractor during the mitigation and disposal from an accidental release shall be the responsibility of the contractor.

1.7.1.2 CONTRACTOR'S LIABILITY FOR ENVIRONMENTAL DAMAGES

Contractor agrees to hold harmless and indemnify the Government for any and all damages of any kind resulting from environmentally harmful activities by the contractor, contractor's employees, agents, or contractors. "Damages" includes personal injury or death, property damages (including diminution of value), environmental restoration and response costs, natural or cultural resource damages or restoration, expert witness and attorney's fees, and reimbursement of any and all expenses incurred to obtain permits as a result of contractor's failure to identify or obtain permits for itself, the Government.

1.7.1.3 CONTACT WITH ENVIRONMENTAL REGULATORY OFFICIALS

Contractor shall immediately advise the TM/Contract Officer, 42nd Contracting Office, and the installation environmental office of the content of all contacts with Federal, State, or local environmental regulators; before, during, and after the performance of this contract concerning the performance of this contract.

1.8 LICENSES AND PERMITS

1.8.1 PERMITS FOR EQUIPMENT USED BY CONTRACTOR IN PERFORMING GOVERNMENT CONTRACTS

For equipment used in the performance of this contract, contractor shall obtain in contractor's name and at no additional expense to the Government all permits, coordination, certifications or other regulatory authorization necessary to perform and complete the work required by this contract under applicable environmental laws and regulations. "Applicable environmental laws and regulations" includes but is not limited to: the Clean Air Act, Clean Water Act, Resource Conservation and Recovery Act, Comprehensive Environmental Response, Compensation and Liability Act, (CERCLA), Toxic Substances Control Act, Federal Insecticide Fungicide and Rodenticide Act, Coastal Zone Management Act, Endangered Species Act, National Historic Preservation Act, Safe Drinking Water Act, Emergency Planning and Community Right-to-Know Act, Oil Pollution Act, and Pollution Prevention Act, and State, County, and Local laws and regulations on the same subjects.

1.8.2 PERMITS NEEDED FOR CONSTRUCTION, EXCAVATION, MODIFICATION, RENOVATION, DEMOLITION, INSTALLATION, OR OTHER ALTERATION OF BUILDINGS, STRUCTURES, EQUIPMENT, INSTALLATIONS, REAL PROPERTY OR SYSTEMS

Contractor shall identify all Federal, State, County, or local permits, coordination, certifications or other regulatory authorization requirements under all applicable environmental laws and regulations. Contractor shall then prepare in draft, and submit to the Contracts office for review, all applicable permit applications, coordination, notices, or other required filings, together with all supporting data. Permit applications, notifications or other documents that must be submitted by the Government shall be submitted by the Government, and any documents that must be submitted by the contractor shall be returned to the contractor for submission after review. No work requiring permit or other written authorization shall proceed before the contractor has the permit or authorization or a copy thereof in its possession. Copies of all required environmental permits shall be submitted to the Contracts office to be forwarded to the installation environmental office to have on file prior to the start of work.

1.9 PESTICIDE DELIVERY, STORAGE, AND HANDLING

Except as may be specified elsewhere in this contract, contractor shall not use or apply pesticides (such as insecticides, rodenticides, herbicides or weed-killers) without specific written prior approval of the TM/Contract Administrator.

1.9.1 Delivery and Storage

Deliver pesticides to the site in the original, unopened containers

bearing legible labels indicating the EPA registration number and the manufacturer's registered uses. Store pesticides according to manufacturer's instructions and under lock and key when unattended.

1.9.2 Handling Requirements

Formulate, treat with, and dispose of pesticides and associated containers in accordance with label directions and use the clothing and personal protective equipment specified on the labeling for use during each phases of the application. Furnish SDSs for pesticide products.

1.10 SOLID WASTE MANAGEMENT PERMIT

Provide the Contracting Officer with written notification of the quantity of anticipated solid waste or debris that is anticipated or estimated to be generated by construction. Include in the report the locations where various types of waste will be disposed or recycled. Include letters of acceptance from the receiving location or as applicable; submit one copy of the receiving location state and local Solid Waste Management Permit or license showing such agency's approval of the disposal plan before transporting wastes off Government property.

1.10.1 Monthly Solid Waste Disposal Report

Monthly, submit a solid waste disposal report to the Contracting Officer. For each waste, the report will state the classification (using the definitions provided in this section), amount, location, and name of the business receiving the solid waste.

PART 2 PRODUCTS

2.1 ASBESTOS

- A. Asbestos shall not be used or included in this project unless specifically approved in writing by the 42nd Contracting Office and installation environmental office.
- B. If workers should encounter any suspect asbestos-containing material such as fibrous insulation, pipe wrap, asbestos-containing plaster, etc., contractor shall cease any activity that may disturb the material and immediately contact the TM/Contract Administrator for coordination with the installation environmental office.
- C. If potential asbestos-containing material has been identified in connection with proposed work, all asbestos abatement activities shall be conducted by a certified Safe-State contractor, following base asbestos protocol, asbestos specification section, Maxwell AFB Asbestos Management and Operations Plan. Contractor shall follow all applicable governing regulations, including, but not limited to:
29 CFR 1926.1101 - OSHA Safety and Health Regulations for Construction, Subpart Z, Toxic and Hazardous Substances,
29 CFR 1910.1001 - OSHA Standards, Subpart Z, Toxic and Hazardous Substances, and CFR Part 61 - EPA National Emission Standards for Hazardous Air Pollutants (NESHAPS)

2.2 POLYCHLORINATED BIPHENYLS (PCBs)

PCBs shall not be used or included in this project.

If contractor encounters any lighting ballasts, electrical transformers, or other equipment that is suspected to contain PCBs, contractor shall contact the TM/Contract Administrator for notification to the installation environmental office. If the equipment is not labeled or does not specify that the unit has "no PCBs," it is considered to be suspect and shall be handled as if it may contain PCBs. Disposal shall be coordinated through installation environmental office. Contractor shall not remove any hazardous waste from the installation without installation environmental office knowledge prior to scheduling.

2.3 LEAD-BASED PAINT

Lead-based paint shall not be used or included in this project.

- A. In buildings that were constructed prior to 1978, it should be assumed that lead-based paint is present unless sampling results indicate otherwise. Any activities that will potentially disturb lead-based paint shall be coordinated through the installation environmental office. Contractor is responsible for complying with the Maxwell AFB Lead-Based Paint Management Plan and all applicable Federal, State, and local regulations, including OSHA Lead in Construction Standard 29 CFR 1926.62. Contractor shall be properly trained and is responsible for worker training and protection requirements. Documentation of training shall be provided to the 42nd Contracting Office prior to start of work.
- B. If suspect lead-based paint is encountered during performance of work, contractor shall coordinate lead-based paint work plan through TM/Contract Administrator for coordination with installation environmental office before proceeding with any activities such as sanding, scraping, demolition, or other activities that may disturb lead-based paint.

2.4 OZONE-DEPLETING SUBSTANCES

- A. The use of Class I ozone-depleting substances is generally prohibited. Any use of a Class I ozone-depleting substance shall be approved through the installation environmental office prior to use. All Class I ODSs recovered on site shall be returned to the base Civil Engineering HVAC shop (42 CES/CEOH). All reasonable efforts shall be made to reduce usage of Class II ozone-depleting substances. All usage shall be reported to 42 CES/CEIE.
- B. Contractors shall follow regulations concerning ODS as specified in 42 USC 7671 (b), (c), and (d) and 40 CFR Part 82, Subpart E. All Class I and Class II ODS shall be labeled IAW these regulations.
- C. The contractor shall comply with the applicable requirements of Sections 608 and 609 of the Clean Air Act (42 USC 7671g, National Recycling and Emission Reduction Program and 7671h, Servicing of Motor Vehicle Air Conditioners) as each or both apply to the contract.

2.5 HAZARDOUS MATERIALS, POLLUTION PREVENTION & WASTE MINIMIZATION

- A. When a hazardous material is required in performance of this contract, the contractor is required to submit Contractor's Hazardous Material Questionnaire, Contractor's Environmental Reporting Entry Form, and Material Safety Data Sheets (MSDS) for each hazardous material to be

used. The hazardous material must be approved prior to being brought onto Maxwell AFB or Gunter Annex.

- B. The approval process should be less than 2 days in order to comply with the 10-day suspense time to receive submittals 5 days prior to contract start date. See AF Form 66.

PART 3 EXECUTION

3.1 SITE DISTURBANCE DURING CONSTRUCTION ACTIVITIES

3.1.1 National Pollutant Discharge Elimination System (NPDES)

For any project that will disturb an area "equal to" or "more than" 1 acre, the contractor is required to submit an ADEM Notice of Intent (NOI) under the NPDES General Construction Permit. A completed copy of the NOI must be submitted to the 42nd Contracting Office and Environmental Department prior to any site work. The "site" encompasses the collective area of disturbance for any project, even if the disturbed areas are non-contiguous. The contractor is responsible for all required inspections under ADEM's NPDES General Permits. However, Base Environmental will perform additional oversight inspections and instruct changes, alterations and/or modifications as necessary.

3.1.2 Best Management Practices

The contractor shall use industry recognized Best Management Practices (BMPs) to the maximum extent practical to avoid and control storm water runoff from the construction site and any temporary roads that may be used to access the site (entrances/exits). Contractor shall perform all work under this contract in such a manner that no pollutants of any kind are released into ditches, storm drains, streams, lakes, or other surface waters on or connected to the site. BMPs shall be implemented prior to site disturbance and maintained throughout project duration until permanent stabilization has been achieved. Protective measures shall include:

3.1.2.1 Silt Fencing

Install silt fencing around all storm drains and runoff channels that can be potentially impacted by the construction/demolition activity. Install silt fencing where appropriate and to the maximum extent necessary to prevent removal of particulates and debris with runoff from the site. Refer to the ADEM Handbook for Type A, B and C methods.

3.1.2.2 Wattles

Install wattles in front of curb inlets that will be impacted when sediment run-off is inevitable due to tracking, equipment and supply staging areas and/or other disturbed areas. Wattles shall be in lengths that cover entire inlet opening. Contract Administrator does not recommend blocking curb/street inlets unless absolute necessary. Blocking street inlets will cause temporary ponding which may impact traffic flow. The contractor must make all reasonable attempts to maintain sediment on the construction site to eliminate having to protect street inlets. Wattles are an acceptable practice when protecting drop inlets located in landscaped areas where stakes can be used to hold the wattles in place on a disturbed construction site. Straw wattles shall not be used for drop inlet protection on concrete or asphalt pavement areas

3.1.2.3 Silt Savers

Install silt savers as a primary means for drop inlet protection within the disturbed areas of a construction site. Silt savers come in round or square molds depending on the drop inlet configuration and size. Crushed stone and/or soils shall be used to support the mold and filter fabric in place. Install as per manufacture recommendations..

3.1.2.4 Hay Bales: Place and stake hay bales or other temporary dams where appropriate for impeding storm water flow across large, open areas of disturbed earth and as particulate barriers to prevent erosion and unintended soil relocation. Hay bales shall not be used as a sole source when protecting drop inlets. Silt fencing and/or crushed stone shall be used in support with hay bales to prevent entry of sediment and any construction debris during the activity. Hay bales shall not be used to protect curb inlets.

3.1.2.5 Block and Gravel:

Install block and gravel inlet protection where an impermeable surface (concrete, asphalt, etc.) exists around the drain and in other areas where this type protection is more appropriate to prevent particulate transport to the inlet. The height of the block and gravel inlet structure shall be a minimum of 12 inches. A geotextile fabric shall also be placed as a filter between the block and crushed stone (ALDOT #57 crushed stone or similar grade shall be used).

3.1.2.6 Geotextile Fabric (drop inlet barriers):

The contractor may use a non-woven geotextile fabric as a means to protect drop inlets with metal grates. The drop inlet grate can be removed in order to place a sufficient amount of geotextile fabric inside the storm inlet opening. The grate must be replaced on top of the fabric maintaining a tight fit with no gaps in order to provide a sock-like barrier. Excess fabric shall drape outside the grate allowing for any sediment to be captured. This method allows for construction traffic but must be maintained. Sediment overloaded geotextile fabric must be cleaned and replaced as needed.

3.1.2.7 Stabilization:

All disturbed and exposed soils shall be preserved, covered if needed, in a manner that prevents soil migration with rainfall or runoff. Contractor is responsible for repair of any erosion caused by the contractor's construction activities. All disturbed or exposed soil shall be permanently stabilized at the earliest practicable date. In most cases, seeding is not allowed on the installation; areas shall be repaired with sod, re-vegetation shall be with non-invasive plants that are native species or approved turf species.

3.1.2.8 Concrete & Asphalt Saw-Cutting:

The contractor shall implement means and methods to control and clean-up from saw-cutting activities immediately and not allow for traffic to travel through the saw cut locations until the "saw-cut mud" clean-up activities are completed. Washing into the nearest storm drain is prohibited.

3.1.2.9 Concrete Wash-Outs

The contractor must have a location on site or at an approved location by the TM/Contract Administrator where concrete trucks can wash out. The location must be in an area that will not allow the wastewater to flow or drain into storm inlets, drainage ditches, waterways or roadways. For large projects where multiple concrete placements will be performed, a wash out location must be designated and protected. Typically this is created by using a soil berm and combining with the use of hay bales, silt fencing, and/or wattles.

3.1.2.10 Materials & Fuel Storage:

The contractor must maintain a clean and orderly project site and laydown yard with regards to materials storage. Containers with liquids, oils, lubricants, fuels and other materials must be properly covered and/or stored on site and protected from rainfall and inclement weather. Spill prevention controls and spill response materials must be available and/or on hand in case of a spill. Base Environmental must be notified of any spill for documentation, instructions for clean-up and disposal requirements.

3.1.2.11 Soil, Sand, and Crushed Stone Stock Piles

The contractor must store stock piles in a manner and in a location where sediment run-off will not leave the site. Storm inlets must be protected in affected or in adjacent areas with the use of silt fencing, wattles, berms and/or a combination of thereof, unless sediment control can be maintained on site.

3.1.2.12 Dust Control:

Water shall be used in a manner to control dust during dry periods of the year and continuous during demolition activities. The amount of water used shall be monitored by the contractor. Excess water can create additional problems.

3.1.2.13 Construction Entrances/ Exit Pads

The contractor shall construct an adequate construction entrance/exit pad to protect from vehicle and construction equipment tracking onto roadways, parking lots and other impermeable hard surfaces. A layer of non-woven geotextile fabric shall be placed in a designated location(s) for the project. ALDOT #1 crushed stone shall be placed with a minimum thickness of 6 inches on the fabric. The pad must be constructed to an adequate length and width for the project traffic and equipment. The contractor shall not use crusher run, river gravel, or small crushed stone such as ALDOT #57 or #67 stone. This material compacts and thus does not provide an adequate surface for flexing rubber tires to remove mud and sediment. It is the responsibility of the contractor to maintain and replace the crushed stone when conditions do not provide adequate protection from off-site tracking.

3.1.3 ENFORCEMENT MECHANISM - CONSTRUCTION SITE STORM WATER RUNOFF CONTROL

- A. All project sites will be subject to inspections by CEIE and/or CE project managers. Documenting inspections and non-compliance issues will occur on monthly summary reports to the Government Quality Assurance Evaluator (QAE) for Maxwell AFB.

- B. If site condition(s) warrants an instruction for correction or implementation of a BMP, this item will be verbally discussed between the Contract Administrator, the contractor's representative, the CEIE representative and the CE project manager. Instructions will be given if a site condition is, or has the potential to become, a NPDES non-compliance issue. The contractor will be given a deadline by which to implement, change and/or fix the issue, depending on the finding.
- C. A follow up inspection by CEIE or the CE project manager will be performed to observe for site corrections. If the site correction has not been implemented or fixed due to a lack of effort, lack of concern or contractor negligence, then a written warning will be documented and placed on file. The contractor will be given a warning letter and a final deadline for implementing the mandatory instruction.
- D. If, on a 2nd follow up site inspection, the contractor has not completed the Base's instruction, a work stoppage, at the contractor's loss of time, will be enforced until the compliance issue or issues have been addressed.
- E. If more than one work stoppage has to be enforced for a single project, due to non-compliance issues, the general contractor will be subject to removal from all future bid lists for a time determined by the Contract Administrators.
- F. The above process can be used as guidance for all projects. However, CEIE and CE reserve the right to work with contractors on a project-to-project basis, based on special conditions. Special conditions may be determined by CEIE and CE. Special conditions may include, but are not limited to, situations such as the following:
 - 1. Unforeseen weather conditions. (i.e. flooding, severe thunderstorms with significant rainfall events, etc...)
 - 2. Vandalism
 - 3. Contractor making continuous efforts to comply with standards, using means and methods typically applied in the construction industry, and exhibiting an overall concern with maintaining a site in compliance with the Base and under State guidelines.
- G. A maintenance plan should be developed to address issues that need immediate corrections, which may result in off-site discharges, when the contractor is not on Base, refuses to return in a timely manner to make corrections and/or cannot be contacted. These issues include, but are not limited to, the following: silt fence repair, street sweeping, inlet protection, etc... The cost of these corrections could be passed on to the contractor, if the contractor is found to be at fault due to negligence.

3.2 OTHER PROTECTION OF WATER RESOURCES

3.2.1 GENERAL:

The contractor shall not pollute storm drainage, streams, lakes, or reservoirs with fuels, oils, bitumen, calcium chloride, acids, construction wastes, or other harmful materials or pollutants. It is the

responsibility of the contractor to determine and comply with all applicable Federal, State, regional, municipal, and other regulations.

3.2.2 SPILLAGE:

The contractor shall take special measures to prevent chemical, fuels, oils, greases, bituminous materials, waste washings, herbicides, paints, cement, and surface drainage from entering public waters. In the event of a spill, the contractor must first notify the Maxwell AFB Fire Department (953-9911), and then notify the TM/Contract Administrator and the installation environmental office. Contractor is responsible to make all required notifications to Federal, State, or local authorities as soon as possible.

3.2.3 WASHING AND CURING WATER

Water used in aggregate processing, concrete curing, foundation, and concrete lift clean-up and other waste water shall not be allowed to enter the storm drainage system.

3.2.4 PAINTING:

Contractor shall provide sufficiently-sized drop cloths at each job site to contain any accidental spillage during paint usage. All containers shall be placed on drop cloths before opening and at all times during use. Any unused paint and its containers brought onto the installation by the contractor shall be properly sealed and taken off the installation by the contractor upon completion of the job.

3.2.4.1 Latex Paint

Locations (sanitary waste drains/entry points) for cleaning of brushes and other paint application equipment are confined to only those designated by installation environmental personnel for the particular job. At the designated sanitary waste disposal site, the volume of water used for cleaning shall be sufficient to provide for adequate dilution of the paint material.

3.2.4.2 Oil-Based Paint, Polyurethane, and Other Chemicals or Cleaning Solutions

Contractor shall properly dispose of all oil-based paint, polyurethane, cleaning solutions, containers, and used applicators at an off-base site.

3.2.5 CARPET CLEANING

Contractor shall vacuum-extract or otherwise capture all cleaning fluids and chemicals applied to carpet during cleaning procedure. Fluids shall be collected in a portable tank and transported off the installation for proper disposal in accordance with all applicable regulations. No material or fluid used in carpet cleaning activities shall be disposed of anywhere on the installation.

3.3 PROTECTION OF LAND RESOURCES

General: It is intended that the land resources within the project boundaries and outside the limits of permanent work performed under this contract be preserved in their present condition or be restored to a condition after completion of construction that will appear as the natural

state and not detract from the appearance of the project. The contractor shall limit his construction activities to areas defined by the Drawings or Specifications.

3.4 CONTROL OF AIR EMISSIONS

- a. Contractor's actions shall conform to all applicable State, Federal, Air Force and MAFB requirements and directives for the control of air emissions under this and all contracts to be executed within the boundaries of Maxwell-Gunter AFB and associated GSU's. When installing, servicing or operating air pollution producing equipment, all work shall be completed in accordance with manufactures specifications to ensure optimal operation and minimal emissions to the environment. When new or remanufactured equipment, including boilers and generators, is being installed, all necessary specifications and documentation required to calculate air emissions shall be provided to 42 CES/CEIE 60 days prior to installation. Required emissions data consists of unit capacity, input rating, output rating, and low emissions modifications.
- b. Burning shall only be permissible when approved in writing by a representative from 42 CES/CEIE. All burning operations shall conform with applicable State, Federal, Air Force and MAFB requirements and directives. It shall never be permissible to burn or allow the burning of any plastic, rubber, paper, treated lumber or other material that is not vegetative waste generated on the project site.
- c. Dust control measures shall be employed when necessary to control dust production on a work site. Vehicles leaving the site shall have all practical amounts of dust/dirt removed by brushing, washing or other equally effective method to ensure that generation of airborne dust due to vehicle movement and tracking onto roadways is minimized. All bulk containers of loose material to be moved to or from a work site shall be covered to minimize airborne dust during transport.

3.5 WASTE DISPOSAL

3.5.1 GENERAL

Installation environmental office shall be notified 24 hours before any waste will be allowed to leave the facility. Recurrence of pickups can be scheduled for the duration of the project or throughout current fiscal year. All waste containers shall be properly labeled in accordance with applicable regulations. Quantity of waste materials shall be provided to the 42nd Contracting Office and installation environmental office.

3.5.2 HAZARDOUS WASTE GENERATION, HANDLING, AND DISPOSAL:

Work done under this contract is to be performed on a government facility. According to rules and procedures of the United States Environmental Protection Agency, the Federal facility is required to have a generator identification number under the RCRA and to be responsible for wastes (as defined under RCRA and TSCA) produced, managed, stored, disposed on, or transported from the facility. Contractor shall, to the greatest extent practicable, use materials, processes, and techniques that will avoid the creation of hazardous waste. Under no circumstances shall contractor bring onto the site hazardous waste that has been generated elsewhere. No hazardous waste, petroleum waste, or universal waste shall be disposed of in solid waste containers.

Prior to generation of any hazardous wastes, contractor shall prepare and submit a written waste management and disposal plan for all hazardous wastes generated on the site, and all planned activities regarding hazardous materials and hazardous waste shall be coordinated through the Contract Administrator with the installation environmental office. Contractor shall follow this plan once it has been approved in writing by the CO in conjunction with the environmental office and shall dispose of all hazardous waste in accordance with all Federal, State, and local requirements. Contractor shall coordinate and schedule all disposal of hazardous waste through the CO in conjunction with the installation environmental office. Installation environmental office must authorize, on site, all shipments of hazardous waste from Maxwell Air Force Base.

3.5.3 DISPOSAL OF NON-RCRA WASTES:

All non-hazardous wastes generated on the site as a result of this contract shall be disposed of properly, in accordance with all Federal, State, and local requirements. Prior to creation of such wastes, the contractor shall submit to the installation environmental management function, through the TM/Contract Administrator, a plan for disposal of wastes. Such plan shall include the types of waste to be created, estimated quantity expected, how they shall be stored, managed and disposed. Contractor shall follow this plan once it has been approved by the installation environmental office and TM/Contract Administrator. Such wastes shall not be created until approved by the TM/Contract Administrator. Unless specified otherwise in the contract, non-hazardous waste shall be disposed of off base by the contractor in a legal manner that will not result in liability to the United States Air Force. Waste manifest, Bill of Lading, and/or landfill receipt shall be provided to the 42nd Contracting Office for forwarding to installation environmental office.

3.5.4 CONSTRUCTION DEBRIS:

This contract may require the contractor to remove clean construction debris from the site and dispose of the debris off the installation in a manner that is in compliance with all applicable Federal, State, and local regulations. (Site soil, water, or other site media are not covered by this paragraph.) Such debris shall be free of all contamination, including but not limited to, lead paint, asbestos, and insecticides. Prior to removal of any construction debris, that debris shall be certified by an installation representative to be free of contamination and this certification shall be provided to the TM/Contract Administrator. To expedite work, this may be accomplished by a FAX, or other suitable electronic means; however, the original certification form shall be provided to the TM/Contract Administrator. All necessary information shall be provided and the document shall be signed by an authorized installation representative. The certification form is provided at the end of this section of the specifications. All construction debris removed from the installation shall be covered by a certification. The contractor shall arrange with the installation point of contact whether all debris will be covered by one certification or if several certifications will be required.

3.5.5 RECYCLING

Contractor shall recycle material to the greatest practicable extent in order to reduce disposal of solid waste. Where construction and/or demolition debris such as concrete, brick, asphalt, wood, carpeting, or

other material can be recycled, this alternative will be considered. Contractor shall submit weight verification of recycled/reclaimed material to the 42nd Contracting Office for submission to the installation environmental office for solid waste diversion tracking.

3.5.6 ORGANIC WASTES

Organic waste from ground-clearing operations may usually be disposed of at the installation compost facility. Contractor shall check with the TM/Contract Administrator for final clearance.

3.5.7 CONSOLIDATED WASTE DISPOSAL PLANS:

Contractor may, at contractor's option, submit for approval as specified above one consolidated plan for handling hazardous and non-hazardous wastes.

3.6 EARTHWORK AND REMOVAL OF POTENTIALLY CONTAMINATED MEDIA:

3.6.1 ENCOUNTERING UNEXPECTED CONTAMINATED SOIL OR GROUNDWATER

Unless otherwise specified elsewhere in this contract, the site has been inspected and is, consistent with best professional judgment, free of environmental contamination or pollution. However, work under this contract will be performed on a military installation, where the history of prior military and industrial activities is not necessarily completely known, and unexpected conditions can always arise. Contractor or contractor personnel may encounter soil or groundwater that is suspected to be contaminated, either because of odors, colors, free liquids, unexpected construction debris, or other suspicious conditions. Should this occur, contractor shall cease activity in the area except those initial actions necessary to protect workers, the site, and other personnel. Contractor shall then immediately notify the TM/Contract Administrator and the installation environmental office at 953-5260.

3.6.2 Chlordane

Facilities proposed for demolition, significant renovation, and /or additions that were constructed prior to 1990, will be suspect for the presence of chlordane and other pesticides. It is known that chlordane has been used on Maxwell AFB as a pesticide prior to its EPA ban in 1989. We require that soils around the building foundations be tested for the presence of pesticides (chlordane). The EPA has specific handling and disposal requirements for soils and/or any waste streams that have been contaminated with chlordane that exceed threshold limits. Any suspected chlordane-containing soil will be subject to these provisions.

3.6.3 REMOVAL OF POTENTIALLY CONTAMINATED MEDIA

The following provisions prohibit the removal from the installation of potentially contaminated soil or other materials found on site and are included, in an abundance of caution, for the protection of the Government, the installation, and the contractor.

- a. Notwithstanding any another clause in this contract, including but not limited to all standard site work general provisions; no media by-product resulting from site preparation, construction or excavation shall be moved off the installation where the construction is occurring without written permission from Contracting Officer. If the

construction is off the installation, no media by-product shall be moved off the construction site.

- b. The contractor shall: (1) leave the media in place at the site, subject to appropriate erosion control; or (2) haul the media to, and place it at, a location on the installation that has been designated either in this contract or in writing by the TM/Contract Administrator; and (3) if unforeseen difficulties arise, such as excessive quantity of media is generated, the contractor shall advise the TM/Contract Administrator and shall not remove media from the site without written authorization from the Contracting Officer.

3.7 RESOURCE CONSERVATION

Consumption of resources shall be minimized where possible. Contractors shall shut down electrical and gas-powered equipment when not in use and minimize the consumption of water and other resources.

3.8 PROTECTION OF CULTURAL RESOURCES

3.8.1 HISTORIC FACILITIES:

Modifications or renovations to any facilities on Maxwell-Gunter AFB that are listed on or eligible for the National Register of Historic Places or exceed 50 years in age must be reviewed and approved by the installation Cultural Resource Manager. If the proposed action affects any elements that contribute to the facility's historical characteristics, these actions are subject for review and approval by the State Historic Preservation Office (SHPO). Plans and drawings for projects that will impact historic facilities shall be submitted to installation environmental office for potential submission to SHPO. SHPO review is a minimum of 30 days, and work shall not proceed until authorized through the CO in conjunction with the installation environmental office. If the contractor or contractor's representative causes any damage to historical characteristics of a historic facility, contractor shall be responsible for full restoration of damage.

3.8.2 UNEXPECTED ARTIFACTS OR RELICS:

Should contractor or employees, in the course of site preparation or other work on this contract, find unexpected historic or archeological remains, such as bones, arrow points, pottery remnants, foundations, or other evidence of previous uses of the site, contractor shall cease further site-disturbing activity and immediately notify the TM/Contract Administrator and installation environmental office.

3.9 PROTECTION OF NATURAL RESOURCES

3.9.1 PROTECTION OF SPECIAL WATER RESOURCES

If project will involve: any disturbance below the ordinary high water mark of a pond, lake, stream, river, or other water body; any work within wetland areas; withdrawal of water from water bodies; or discharges into water bodies; planned work shall be coordinated through installation environmental office. Contractor shall obtain any required Federal, State, or local permits and submit copy of permit(s) to installation environmental office prior to work start.

3.9.2 PRESERVATION OF TREES, SHRUBS, AND OTHER LANDSCAPE:

The following requirements shall be observed by the contractor in order to protect the existing landscape (to include trees, shrubs, turf, flowers, flower beds, sidewalks, patios, fences, etc.):

3.9.2.1 Tree Protection:

All trees shall be protected unless they are designated on the plans to be removed. Contractor shall install protective fencing around trees in the construction area, at a radius extending from the tree trunk at least out to the drip line of the tree. No vehicle parking or storage of materials is allowed under tree canopies or within the drip line/root zone of the trees or beside existing shrub plantings. Work shall not damage roots of existing trees without prior coordination with installation Natural Resources Manager. No fences, ropes, cables, signs, or devices of any kind shall be attached to any tree. Pruning or removal of trees/shrubs shall only be permitted after written or electronic coordination with the Natural Resources Manager in the environmental office or the Horticulturist at the installation greenhouse. The TM/Contract Administrator and installation environmental office shall be notified immediately of any damage to trees caused by contractor or contractor's representative. The 42nd Contracting Office will direct measures, if any, to treat the injury. If the contractor or contractor's representative causes the death or 60% decline to any protected tree(s) within a 24-month period, the contractor shall remove and replace the damaged tree(s) with size and species of tree(s) directed by the 42nd Contracting Office. The size of replacement tree(s) shall equal caliper size of removed trees. Contractors shall replace trees in accordance with the AETC Tree Instruction, AETCI 32-7065.

3.9.2.2 Turf Protection:

No driving across, parking, or other equipment operations on existing turf or storage of materials on turf areas shall be permitted unless prior approval has been obtained from the TM/Contract Administrator. If any lawn damage occurs (even with special permission), the contractor shall restore the lawn with approved sod, per "Maxwell Air Force Base Landscape Management Operational Instruction." (Turf in most areas is Tifton 419 Bermuda grass.) If sod fails to grow or is not viable within 60 days of the date of substantial completion of the contract, sod shall be replaced at contractor's expense. The use of grass seed to repair turf damage is not permitted.

3.9.3 REPAIR OR REPLACEMENT OF DAMAGE:

If any failure to comply with these environmental protection provisions or any other provisions of this contract results in damage to government resources, contractor shall be held responsible. Any landscaping, turf, or other natural resource damage shall be repaired, at no additional cost to the government, to the government standards as defined in "Maxwell Air Force Base Landscape Management Operational Instruction." Repair work shall be inspected and accepted by the Contracts office or TM/Contract Administrator. Any discrepancies shall be fixed before acceptance.

3.10 CONTACT INFORMATION

If at any time, contractor has environmental protection concerns or questions, first attempt to contact the Contracting Officer, who can

For immediate response in case of any chemical release or spill, contact the MAFB Fire Department at 953-9911. (From a MAFB installation phone, dial 911.)

As representative of Maxwell Air Force Base (insert name of installation),
I am authorized to certify, and hereby do so certify, that the construction debris to be removed from the Government project site at:

CERTIFICATION:

Printed Name, Rank or Grade, and Duty Title:

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-- End of Section --
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SECTION 01 42 00

SOURCES FOR REFERENCE PUBLICATIONS

02/19

PART 1 GENERAL

1.1 REFERENCES

Various publications are referenced in other sections of the specifications to establish requirements for the work. These references are identified in each section by document number, date and title. The document number used in the citation is the number assigned by the standards producing organization (e.g., ASTM B564 Standard Specification for Nickel Alloy Forgings). However, when the standards producing organization has not assigned a number to a document, an identifying number has been assigned for reference purposes.

1.2 ORDERING INFORMATION

The addresses of the standards publishing organizations whose documents are referenced in other sections of these specifications are listed below, and if the source of the publications is different from the address of the sponsoring organization, that information is also provided.

ACOUSTICAL SOCIETY OF AMERICA (ASA)
1305 Walt Whitman Road, Suite 300
Melville, NY 11747-4300
Ph: 516-576-2360
Fax: 631-923-2875
E-mail: asa@acousticalsociety.org
Internet: <https://acousticalsociety.org/>

AIR CONDITIONING CONTRACTORS OF AMERICA (ACCA)
2800 Shirlington Road, Suite 300
Arlington, VA 22206
Ph: 703-575-4477
Internet: <https://www.acca.org/>

AIR DUCT COUNCIL (ADC)
1901 N. Roselle Road, Suite 800
Schaumburg, IL 60195
Ph: 847-706-6750
Fax: 847-706-6751
E-mail: info@flexibleduct.org
Internet: <https://flexibleduct.org/>

AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL, INC. (AMCA)
30 West University Drive
Arlington Heights, IL 60004-1893
Ph: 847-394-0150
Fax: 847-253-0088
E-mail: communications@amca.org
Internet: <http://www.amca.org>

AIR-CONDITIONING, HEATING AND REFRIGERATION INSTITUTE (AHRI)
2111 Wilson Blvd, Suite 400
Arlington, VA 22201

Ph: 703-524-8800
Internet: <http://www.ahrinet.org>

ALUMINUM ASSOCIATION (AA)
1400 Crystal Drive
Suite 430
Arlington, VA 22202
Ph: 703-358-2960
E-Mail: info@aluminum.org
Internet: <https://www.aluminum.org/>

AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION (AAMA)
1900 E Golf Rd, Suite 1250
Schaumburg, IL 60173
Ph: 847-303-5664
E-mail: customerservice@aamanet.org
Internet: <https://aamanet.org/>

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS
(AASHTO)
444 North Capital Street, NW, Suite 249
Washington, DC 20001
Ph: 202-624-5800
Fax: 202-624-5806
E-Mail: info@aaashto.org
Internet: <https://www.transportation.org/>

AMERICAN BEARING MANUFACTURERS ASSOCIATION (ABMA)
330 N. Wabash Ave., Suite 2000
Chicago, IL 60611
Ph: 202-367-1155
E-mail: info@americanbearings.org
Internet: <https://www.americanbearings.org/>

AMERICAN CONCRETE INSTITUTE (ACI)
38800 Country Club Drive
Farmington Hills, MI 48331-3439
Ph: 248-848-3700
Fax: 248-848-3701
Internet: <https://www.concrete.org/>

AMERICAN CONFERENCE OF GOVERNMENTAL INDUSTRIAL HYGIENISTS (ACGIH)
1330 Kemper Meadow Drive
Cincinnati, OH 45240
Ph: 513-742-2020
Fax: 513-742-3355
Internet: <https://www.acgih.org/>

AMERICAN GAS ASSOCIATION (AGA)
400 North Capitol Street, NW
Suite 450
Washington, D.C. 20001
Ph: 202-824-7000
Internet: <https://www.aga.org/>

AMERICAN HARDBOARD ASSOCIATION (AHA)
1210 West Northwest Highway
Palatine, IL 60067
Ph: 847-934-8800

Fax: 847-934-8803
E-mail: aha@hardboard.org
Internet: <http://domensino.com/AHA/>

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)
130 East Randolph, Suite 2000
Chicago, IL 60601
Ph: 312-670-5444
Fax: 312-670-5403
Steel Solutions Center: 866-275-2472
E-mail: solutions@aisc.org
Internet: <https://www.aisc.org/>

AMERICAN INSTITUTE OF TIMBER CONSTRUCTION (AITC)
7012 South Revere Parkway, Suite 140
Centennial, CO 80112
Ph: 503-639-0651
Fax: 503-684-8928
E-mail: mschoen@wclib.org
Internet: <http://www.aitc-glulam.org>

AMERICAN IRON AND STEEL INSTITUTE (AISI)
25 Massachusetts Avenue, NW Suite 800
Washington, DC 20001
Ph: 202-452-7100
Internet: <https://www.steel.org/>

AMERICAN LUMBER STANDARDS COMMITTEE (ALSC)
7470 New Technology Way, Suite F
Frederick, MD 21703
Ph: 301-972-1700
Fax: 301-540-8004
E-mail: alsc@alsc.org
Internet: <http://www.alsc.org>

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)
1899 L Street, NW, 11th Floor
Washington, DC 20036
Ph: 202-293-8020
Fax: 202-293-9287
E-mail: storemanager@ansi.org
Internet: <https://www.ansi.org/>

AMERICAN PETROLEUM INSTITUTE (API)
1220 L Street, NW
Washington, DC 20005-4070
Ph: 202-682-8000
Internet: <https://www.api.org/>

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)
1801 Alexander Bell Drive
Reston, VA 20191
Ph: 800-548-2723; 703-295-6300
Internet: <https://www.asce.org/>

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING
ENGINEERS (ASHRAE)
1791 Tullie Circle, NE
Atlanta, GA 30329

Ph: 404-636-8400 or 800-527-4723
Fax: 404-321-5478
E-mail: ashrae@ashrae.org
Internet: <https://www.ashrae.org/>

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)
Two Park Avenue
New York, NY 10016-5990
Ph: 800-843-2763
Fax: 973-882-1717
E-mail: customercare@asme.org
Internet: <https://www.asme.org/>

AMERICAN SOCIETY OF SAFETY PROFESSIONALS (ASSP)
520 N. Northwest Highway
Park Ridge, IL 60068
Ph: 847-699-2929
E-mail: customerservice@assp.org
Internet: <https://www.assp.org/>

AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)
18927 Hickory Creek Drive, Suite 220
Mokena, IL 60448
Ph: 708-995-3019
Fax: 708-479-6139
Internet: <http://www.asse-plumbing.org>

AMERICAN WATER WORKS ASSOCIATION (AWWA)
6666 W. Quincy Avenue
Denver, CO 80235 USA
Ph: 303-794-7711 or 800-926-7337
Fax: 303-347-0804
Internet: <https://www.awwa.org/>

AMERICAN WELDING SOCIETY (AWS)
8669 NW 36 Street, #130
Miami, FL 33166-6672
Ph: 800-443-9353
Internet: <https://www.aws.org/>

AMERICAN WOOD COUNCIL (AWC)
222 Catoctin Circle SE, Suite 201
Leesburg, VA 20175
Ph: 800-890-7732
Fax: 412-741-0609
E-mail: publications@awc.org
Internet: <https://www.awc.org/>

AMERICAN WOOD PROTECTION ASSOCIATION (AWPA)
P.O. Box 361784
Birmingham, AL 35236-1784
Ph: 205-733-4077
Fax: 205-733-4075
Internet: <http://www.awpa.com>

APA - THE ENGINEERED WOOD ASSOCIATION (APA)
7011 South 19th St.
Tacoma, WA 98466-5333
Ph: 253-565-6600

Fax: 253-565-7265
Internet: <https://www.apawood.org/>

ASSOCIATED AIR BALANCE COUNCIL (AABC)
1220 19th St NW, Suite 410
Washington, DC 20036
Ph: 202-737-0202
Fax: 202-315-0285
E-mail: info@aabc.com
Internet: <https://www.aabc.com/>

ASSOCIATION OF EDISON ILLUMINATING COMPANIES (AEIC)
600 North 18th Street
P.O. Box 2641
Birmingham, AL 35291
Ph: 205-257-3839
Fax: 205-257-2540
Internet: <https://aeic.org/>

ASTM INTERNATIONAL (ASTM)
100 Barr Harbor Drive, P.O. Box C700
West Conshohocken, PA 19428-2959
Ph: 610-832-9500
Fax: 610-832-9555
E-mail: service@astm.org
Internet: <https://www.astm.org/>

BACNET INTERNATIONAL (BTL)
BACnet Testing Laboratories
1827 Powers Ferry Road
Building 14, Suite 100
Atlanta, GA 30339
Ph: 770-971-6003
Fax: 678-229-2777
E-mail: info@bacnetinternational.org
Internet: <https://www.bacnetlabs.org/>

BUILDERS HARDWARE MANUFACTURERS ASSOCIATION (BHMA)
355 Lexington Avenue, 15th Floor
New York, NY 10017
Ph: 212-297-2122
Fax: 212-370-9047
Internet: <https://www.buildershardware.com/>

CALIFORNIA AIR RESOURCES BOARD (CARB)
1001 I Street
Sacramento, CA 95814
Ph: 800-242-4450
Email: helpline@arb.ca.gov
Internet: <https://ww2.arb.ca.gov/>

CALIFORNIA DEPARTMENT OF PUBLIC HEALTH (CDPH)
PO Box 997377, MS 0500
Sacramento, CA 95899-7377
Ph: 916-558-1784
Internet: <https://www.cdph.ca.gov/>

CAST IRON SOIL PIPE INSTITUTE (CISPI)
2401 Fieldcrest Drive

Mundelein, IL 60060
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Internet: <https://www.cispi.org/>

CENTERS FOR DISEASE CONTROL AND PREVENTION (CDC)
1600 Clifton Road
Atlanta, GA 30329-4027
Ph: 800-232-4636
TTY: 888-232-6348
Internet: <https://www.cdc.gov>

COMPRESSED GAS ASSOCIATION (CGA)
14501 George Carter Way, Suite 103
Chantilly, VA 20151-1788
Ph: 703-788-2700
Fax: 703-961-1831
E-mail: cga@cganet.com
Internet: <https://www.cganet.com/>

CONCRETE REINFORCING STEEL INSTITUTE (CRSI)
933 North Plum Grove Road
Schaumburg, IL 60173-4758
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Fax: 847-517-1206
Internet: <http://www.crsi.org/>

CONSUMER ELECTRONICS ASSOCIATION (CEA)
1919 South Eads St.
Arlington, VA 22202
Ph: 703-907-7600
E-mail: CTA@CTA.tech
Internet: <https://www.cta.tech/>

COPPER DEVELOPMENT ASSOCIATION (CDA)
Internet: <https://www.copper.org/>

CSA GROUP (CSA)
178 Rexdale Blvd.
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Ph: 416-747-4044
Fax: 416-747-2510
E-mail: member@csagroup.org
Internet: <https://www.csagroup.org/>

ELECTRICAL GENERATING SYSTEMS ASSOCIATION (EGSA)
1650 South Dixie Highway, Suite 400
Boca Raton, FL 33432-7462
Ph: 561-750-5575
Fax: 561-395-8557
Internet: <http://www.egsa.org>

ELECTRONIC COMPONENTS INDUSTRY ASSOCIATION (ECIA)
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Alpharetta, GA 30009
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Fax: 678-393-9998
E-mail: emikoski@ecianow.org
Internet: <https://www.ecianow.org>

ELECTRONIC INDUSTRIES ALLIANCE (EIA)
EIA has become part of the ELECTRONIC COMPONENTS INDUSTRY
ASSOCIATION (ECIA)

EUROPEAN UNION (EU)
European Commission
Rue de la Loi 200
1000 Bruxelles
Belgium
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Internet: https://ec.europa.eu/info/index_en

FLUID CONTROLS INSTITUTE (FCI)
1300 Sumner Avenue
Cleveland, OH 44115
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Fax: 216-241-0105
E-mail: fcifluidcontrolsinstitute.org
Internet: <https://fluidcontrolsinstitute.org/>

FLUID SEALING ASSOCIATION (FSA)
994 Old Eagle School Rd. #1019
Wayne, PA 19087-1866
Ph: 610-971-4850
E-mail: info@fluidsealing.com
Internet: www.fluidsealing.com

FM GLOBAL (FM)
270 Central Avenue
Johnston, RI 02919-4949
Ph: 401-275-3000
Fax: 401-275-3029
Internet: <https://www.fmglobal.com/>

FOREST STEWARDSHIP COUNCIL (FSC)
708 First Street North, Suite 235
Minneapolis, MN 55401
Ph: 612-353-4511
E-mail: info@us.fcs.org
Internet: <https://us.fsc.org/>

GLASS ASSOCIATION OF NORTH AMERICA (GANA)
National Glass Association
1945 Old Gallows Rd., Suite 750
Vienna, VA 22182
Ph: 866-342-5642
Ph: 703-442-4890
Fax: 703-442-0630
Internet: <http://www.glasswebsite.com>

GREEN SEAL (GS)
1001 Connecticut Avenue, NW
Suite 827
Washington, DC 20036-5525
Ph: 202-872-6400
Fax: 202-872-4324
E-mail: green SEAL@green SEAL.org
Internet: <https://www.green SEAL.org/>

GYPSUM ASSOCIATION (GA)
962 Wayne Ave., Suite 620
Silver Spring, MD 20910
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Fax: 301-277-8747
E-mail: info@gypsum.org
Internet: <https://www.gypsum.org/>

HYDRAULIC INSTITUTE (HI)
6 Campus Drive, First Floor North
Parsippany, NJ 07054-4405
Ph: 973-267-9700
Fax: 973-267-9055
Internet: <http://www.pumps.org>

HYDRONICS INSTITUTE DIVISION OF AHRI (HYI)
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ILLUMINATING ENGINEERING SOCIETY (IES)
120 Wall Street, Floor 17
New York, NY 10005-4001
Ph: 212-248-5000
Fax: 212-248-5018
E-mail: membership@ies.org
Internet: <https://www.ies.org/>

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)
445 and 501 Hoes Lane
Piscataway, NJ 08854-4141
Ph: 732-981-0060 or 800-701-4333
Fax: 732-981-9667
E-mail: onlinesupport@ieee.org
Internet: <https://www.ieee.org/>

INSTITUTE OF INSPECTION, CLEANING, AND RESTORATION CERTIFICATION
(IICRC)
IICRC Global Resource Center
4043 S. Eastern Ave.
Las Vegas, NV 89119
Ph: 844-464-4272
E-mail: Marketing@iicrcnet.org
Internet: <https://www.iicrc.org/>

INSULATED CABLE ENGINEERS ASSOCIATION (ICEA)
P.O. Box 493
Miamitown, OH 45041-9998
E-mail: info@icea.net
Internet: <https://www.icea.net/>

INSULATING GLASS MANUFACTURERS ALLIANCE (IGMA)
27 N. Wacker Dr. Suite 365
Chicago, IL 60606-2800
Ph: 613-233-1510
Fax: 613-482-9436
E-mail: enquiries@igmaonline.org
Internet: <https://www.igmaonline.org/>

INTELLIGENCE COMMUNITY STANDARD (ICS)
Homeland Security Digital Library
Ph: 831-272-2437
E-mail: hsdl@nps.edu
Internet: <https://www.hsdl.org/c/>

INTERNATIONAL ASSOCIATION OF PLUMBING AND MECHANICAL OFFICIALS
(IAPMO)
4755 E. Philadelphia St.
Ontario, CA 91761
Ph: 909-472-4100
Fax: 909-472-4150
E-mail: iapmo@iapmo.org
Internet: <http://www.iapmo.org>

INTERNATIONAL CODE COUNCIL (ICC)
500 New Jersey Avenue, NW
6th Floor, Washington, DC 20001
Ph: 800-786-4452 or 888-422-7233
Fax: 202-783-2348
E-mail: order@iccsafe.org
Internet: <https://www.iccsafe.org/>

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)
3050 Old Centre Ave. Suite 101
Portage, MI 49024
Ph: 269-488-6382
Fax: 269-488-6383
Internet: <https://www.netaworld.org/>

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)
ISO Central Secretariat
BIBC II
Chemin de Blandonnet 8
CP 401 - 1214 Vernier, Geneva
Switzerland
Ph: 41-22-749-01-11
E-mail: central@iso.ch
Internet: <https://www.iso.org>

INTERNATIONAL SAFETY EQUIPMENT ASSOCIATION (ISEA)
1901 North Moore Street
Arlington, VA 22209-1762
Ph: 703-525-1695
Fax: 703-528-2148
Internet: <https://safetyequipment.org/>

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS
INDUSTRY (MSS)
127 Park Street, NE
Vienna, VA 22180-4602
Ph: 703-281-6613
E-mail: info@msshq.org
Internet: <http://msshq.org>

MARBLE INSTITUTE OF AMERICA (MIA)
Natural Stone Institute
380 E. Lorain Street

Oberlin, OH 44074
Ph: 440-250-9222
Fax: 440-774-9222
E-mail: info@naturalstoneinstitute.org
Internet: <https://www.naturalstoneinstitute.org/>

MASTER PAINTERS INSTITUTE (MPI)
2800 Ingleton Avenue
Burnaby, BC CANADA V5C 6G7
Ph: 1-888-674-8937
Fax: 1-888-211-8708
E-mail: info@paintinfo.com or techservices@mpi.net
Internet: <http://www.mpi.net/>

MIDWEST INSULATION CONTRACTORS ASSOCIATION (MICA)
16712 Elm Circle
Omaha, NE 68130
Ph: 402-342-3463 or 800-747-6422
Fax: 402-330-9702
Internet: <https://www.micainsulation.org/>

NACE INTERNATIONAL (NACE)
15835 Park Ten Place
Houston, TX 77084
Ph: 281-228-6200
Fax: 281-228-6300
E-mail: firstservice@nace.org
Internet: <https://www.nace.org>

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA)
NASA Headquarters
300 E. Street SW, Suite 5R30
Washington, DC 20546
Ph: 202-358-0001
Fax: 202-358-4338
Internet: <https://www.nasa.gov/>

NATIONAL AIR DUCT CLEANERS ASSOCIATION (NADCA)
1120 Route 73, Suite 200
Mt. Laurel, NJ 08054
Toll Free: 855-GO-NADCA
Ph: (856) 380-6810
Fax: (856) 439-0525
Internet: <https://nadca.com/>

NATIONAL ASSOCIATION OF ARCHITECTURAL METAL MANUFACTURERS (NAAMM)
800 Roosevelt Road, Bldg C, Suite 312
Glen Ellyn, IL 60137
Ph: 630-942-6591
Fax: 630-790-3095
E-mail: info@naamm.org
Internet: <http://www.naamm.org>

NATIONAL ELECTRICAL CONTRACTORS ASSOCIATION (NECA)
3 Bethesda Metro Center, Suite 1100
Bethesda, MD 20814
Ph: 301-657-3110
Fax: 301-215-4500
Internet: <https://www.necanet.org/>

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)
1300 North 17th Street, Suite 900
Arlington, VA 22209
Ph: 703-841-3200
Internet: <https://www.nema.org>

NATIONAL ENVIRONMENTAL BALANCING BUREAU (NEBB)
8575 Grovemont Circle
Gaithersburg, MD 20877
Ph: 301-977-3698
Fax: 301-977-9589
Internet: <http://www.nebb.org>

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)
1 Batterymarch Park
Quincy, MA 02169-7471
Ph: 800-344-3555
Fax: 800-593-6372
Internet: <https://www.nfpa.org>

NATIONAL INSTITUTE FOR CERTIFICATION IN ENGINEERING TECHNOLOGIES (NICET)
1420 King Street
Alexandria, VA 22314-2794
Ph: 888-476-4238 (1-888 IS-NICET)
E-mail: tech@nicet.org
Internet: <https://www.nicet.org/>

NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH (NIOSH)
Patriots Plaza 1
395 E Street, SW, Suite 9200
Washington, DC 20201
Ph: 800-232-4636
Fax: 513-533-8347
Internet: <https://www.cdc.gov/niosh/>

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)
100 Bureau Drive
Gaithersburg, MD 20899
Ph: 301-975-2000
Internet: <https://www.nist.gov/>

NATIONAL ROOFING CONTRACTORS ASSOCIATION (NRCA)
10255 West Higgins Road, Suite 600
Rosemont, IL 60018-5607
Ph: 847-299-9070
Fax: 847-299-1183
Internet: <http://www.nrca.net>

NORTH AMERICAN INSULATION MANUFACTURERS ASSOCIATION (NAIMA)
11 Canal Center Plaza, Suite 103
Alexandria, VA 22314
Ph: 703-684-0084
Fax: 703-684-0427
Internet: <https://insulationinstitute.org>

NSF INTERNATIONAL (NSF)
789 North Dixboro Road

P.O. Box 130140
Ann Arbor, MI 48105
Ph: 734-769-8010 or 800-NSF-MARK
Fax: 734-769-0109
E-mail: info@nsf.org
Internet: <http://www.nsf.org>

PLASTIC PIPE AND FITTINGS ASSOCIATION (PPFA)
800 Roosevelt Road
Building C, Suite 312
Glen Ellyn, IL 60137
Ph: 630-858-6540
Fax: 630-790-3095
Internet: <https://www.ppfahome.org/>

PLUMBING AND DRAINAGE INSTITUTE (PDI)
800 Turnpike Street, Suite 300
North Andover, MA 01845
Ph: 978-557-0720 or 800-589-8956
E-Mail: pdi@PDIONline.org
Internet: <http://www.pdionline.org>

SCIENTIFIC CERTIFICATION SYSTEMS (SCS)
2000 Powell Street, Suite 600
Emeryville, CA 94608
Ph: 510-452-8000
Fax: 510-452-8001
E-mail: info@SCSglobalservices.com
Internet: <https://www.scsglobalservices.com/>

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION
(SMACNA)
4201 Lafayette Center Drive
Chantilly, VA 20151-1219
Ph: 703-803-2980
Fax: 703-803-3732
Internet: <https://www.smacna.org/>

SINGLE PLY ROOFING INDUSTRY (SPRI)
465 Waverley Oaks Road, Suite 421
Waltham, MA 02452
Ph: 781-647-7026
Fax: 781-647-7222
E-mail: info@spri.org
Internet: <https://www.spri.org/>

SOCIETY FOR PROTECTIVE COATINGS (SSPC)
800 Trumbull Drive
Pittsburgh, PA 15205
Ph: 877-281-7772 or 412-281-2331
Fax: 412-444-3591
E-mail: customerservice@sspc.org
Internet: <http://www.sspc.org>

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)
400 Commonwealth Drive
Warrendale, PA 15096
Ph: 877-606-7323 or 724-776-4841

Fax: 724-776-0790
E-mail: customerservice@sae.org
Internet: <https://www.sae.org/>

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT (SCAQMD)
21865 Copley Drive
Diamond Bar, CA 91765
Ph: 909-396-2000
E-mail: webinquiry@aqmd.gov
Internet: <http://www.aqmd.gov>

STEEL DOOR INSTITUTE (SDI/DOOR)
30200 Detroit Road
Westlake, OH 44145
Ph: 440-899-0010
Fax: 440-892-1404
E-mail: info@steeldoors.org
Internet: <https://www.steeldoors.org/>

TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY (TAPPI)
15 Technology Parkway South, Suite 115
Peachtree Corners, GA 30092
Ph: 800-332-8686 or 770-446-1400
Fax: 770-446-6947
E-mail: memberconnection@tappi.org
Internet: <http://www.tappi.org>

TELECOMMUNICATIONS INDUSTRY ASSOCIATION (TIA)
1320 North Courthouse Road, Suite 200
Arlington, VA 22201
Ph: 703-907-7700
Fax: 703-907-7727
E-mail: marketing@tiaonline.org
Internet: <https://www.tiaonline.org/>

THE MASONRY SOCIETY (TMS)
105 South Sunset Street, Suite Q
Longmont, CO 80501-6172
Ph: 303-939-9700
Fax: 303-541-9215
E-mail: info@masonrysociety.org
<https://masonrysociety.org/>

TILE COUNCIL OF NORTH AMERICA (TCNA)
100 Clemson Research Boulevard
Anderson, SC 29625
Ph: 864-646-8453
Fax: 864-646-2821
E-mail: info@tileusa.com
Internet: <https://www.tcnatile.com/>

TRIDIUM, INC (TRIDIUM)
3951 Westerre Parkway, Suite 350
Richmond, VA 23233
Ph: 804-747-4771
Fax: 804-747-5204
E-mail: support@tridium.com
Internet: <https://www.tridium.com/>

TRUSS PLATE INSTITUTE (TPI)
218 N. Lee Street, Suite 312
Alexandria, VA 22314
Ph: 703-683-1010
Fax: 866-501-4012
E-mail: info@tpinst.org
Internet: <https://www.tpinst.org/>

TURFGRASS PRODUCERS INTERNATIONAL (TPI)
444 E. Roosevelt Road
#346
Lombard, IL 60148
Ph: 800-405-8873 or 847-649-5555
Fax: 847-649-5678
E-mail: info@turfgrassod.org
Internet: <http://www.turfgrassod.org>

U.S. ARMY CORPS OF ENGINEERS (USACE)
CRD-C DOCUMENTS available on Internet:
<http://www.wbdg.org/ffc/army-coe/standards>
Order Other Documents from:
Official Publications of the Headquarters, USACE
E-mail: hqpublications@usace.army.mil
Internet: <http://www.publications.usace.army.mil/>
or

<https://www.hnc.usace.army.mil/Missions/Engineering-Directorate/TECHINFO/>

U.S. DEPARTMENT OF DEFENSE (DOD)

Order DOD Documents from:

Room 3A750-The Pentagon
1400 Defense Pentagon
Washington, DC 20301-1400
Ph: 703-571-3343
Fax: 215-697-1462

E-mail: customerservice@ntis.gov

Internet: <https://www.ntis.gov/>

Obtain Military Specifications, Standards and Related Publications
from:

Acquisition Streamlining and Standardization Information System
(ASSIST)

Department of Defense Single Stock Point (DODSSP)

Document Automation and Production Service (DAPS)

Building 4/D

700 Robbins Avenue

Philadelphia, PA 19111-5094

Ph: 215-697-6396 - for account/password issues

Internet: <https://assist.dla.mil/online/start/>; account
registration required

Obtain Unified Facilities Criteria (UFC) from:

Whole Building Design Guide (WBDG)

National Institute of Building Sciences (NIBS)

1090 Vermont Avenue NW, Suite 700

Washington, DC 20005

Ph: 202-289-7800

Fax: 202-289-1092

Internet:

<https://www.wbdg.org/ffc/dod/unified-facilities-criteria-ufc>

U.S. DEPARTMENT OF ENERGY (DOE)

1000 Independence Avenue Southwest

Washington, D.C. 20585
Ph: 202-586-5000
Fax: 202-586-4403
E-mail: The.Secretary@hq.doe.gov
Internet: <https://www.energy.gov/>

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)
1200 Pennsylvania Avenue, N.W.
Washington, DC 20004
Ph: 202-564-4700
Internet: <https://www.epa.gov>
--- Some EPA documents are available only from:
National Technical Information Service (NTIS)
5301 Shawnee Road
Alexandria, VA 22312
Ph: 703-605-6060 or 1-800-363-2068
Fax: 703-605-6880
TDD: 703-487-4639
E-mail: info@ntis.gov
Internet: <https://www.ntis.gov/>

U.S. FEDERAL COMMUNICATIONS COMMISSION (FCC)
445 12th Street SW
Washington, DC 20554
Ph: 888-225-5322
TTY: 888-835-5322
Fax: 866-418-0232
Internet: <https://www.fcc.gov/>
Order Publications From:
Superintendent of Documents
U.S. Government Publishing Office (GPO)
732 N. Capitol Street, NW
Washington, DC 20401
Ph: 202-512-1800 or 866-512-1800
Bookstore: 202-512-0132
Internet: <https://www.gpo.gov/>

U.S. GENERAL SERVICES ADMINISTRATION (GSA)
General Services Administration
1800 F Street, NW
Washington, DC 20405
Ph: 1-844-472-4111
Internet: <https://www.gsaelibrary.gsa.gov/ElibMain/home.do>
Obtain documents from:
Acquisition Streamlining and Standardization Information System
(ASSIST)
Internet: <https://assist.dla.mil/online/start/>; account
registration required

U. S. GREEN BUILDING COUNCIL (USGBC)
2101 L St NW, Suite 500
Washington, DC 20037
Ph: 202-828-7422
Internet: <https://new.usgbc.org/>

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)
8601 Adelphi Road
College Park, MD 20740-6001
Ph: 866-272-6272

Internet: <https://www.archives.gov/>
Order documents from:
Superintendent of Documents
U.S. Government Publishing Office (GPO)
732 N. Capitol Street, NW
Washington, DC 20401
Ph: 202-512-1800 or 866-512-1800
Bookstore: 202-512-0132
Internet: <https://www.gpo.gov/>

U.S. NAVAL FACILITIES ENGINEERING COMMAND (NAVFAC)
1322 Patterson Ave. SE, Suite 1000
Washington Navy Yard, DC 20374-5065
Ph: 202-685-9387
Internet: <http://www.navfac.navy.mil>

UNDERWRITERS LABORATORIES (UL)
2600 N.W. Lake Road
Camas, WA 98607-8542
Ph: 877-854-3577 or 360-817-5500
E-mail: CustomerExperienceCenter@ul.com
Internet: <https://www.ul.com/>
UL Directories available through IHS at <https://ihsmarkit.com/>

WASHINGTON STATE ADMINISTRATIVE CODE (WAC)
Legislative Information Center
Cheri Randich, Manager
110 Legislative Building
Olympia, WA 98504-0600
Ph: 360-786-7573
E-mail: support@leg.wa.gov
Internet: <https://app.leg.wa.gov/wac/>

WINDOW AND DOOR MANUFACTURERS ASSOCIATION (WDMA)
2025 M Street, NW, Suite 800
Washington, DC 20036-3309
Ph: 202-367-1157
or
330 N Wabash Avenue, Suite 2000
Chicago, IL 60611
Ph: 312-321-6802
E-mail: membersupport@wdma.com
Internet: <https://www.wdma.com/>

WOOD MOULDING AND MILLWORK PRODUCERS ASSOCIATION (WMMPA)
507 First Street
Woodland, CA 95695
Ph: 530-661-9591
Fax: 530-661-9586
E-mail: info@wmmpa.com
Internet: <https://www.wmmpa.com/>

WOODWORK INSTITUTE (WI)
3188 Industrial Blvd.
West Sacramento, CA 95691
Ph: 916-372-9943
Fax: 916-372-9950
E-mail: info@woodinst.com
Internet: <https://woodworkinstitute.com>

PART 2 PRODUCTS

Not used

PART 3 EXECUTION

Not used

-- End of Section --

SECTION 01 45 00.10 20

QUALITY CONTROL FOR MINOR CONSTRUCTION
02/10, CHG 3: 02/21

PART 1 GENERAL

1.1 SUBMITTALS

Government approval is required. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

QC Plan;

1.2 INFORMATION FOR THE CONTRACTING OFFICER

Prior to commencing work on construction, the Contractor can obtain a single copy set of the current report forms from the Contracting Officer. The report forms will consist of the Contractor Production Report, Contractor Production Report (Continuation Sheet), Contractor Quality Control (CQC) Report, CQC Report (Continuation Sheet), Preparatory Phase Checklist, Initial Phase Checklist, Rework Items List, and Testing Plan and Log.

Deliver the following to the Contracting Officer:

- a. CQC Report: Original and one copy, by 10:00 AM the next working [day][week]after each [day][week]that work is performed;
- b. Contractor Production Report: Original and one copy by 10:00 AM the next working [day][week]after each [day][week]that work is performed;
- c. Preparatory Phase Checklist: Original attached to the original CQC Report and one copy attached to each copy;
- d. Initial Phase Checklist: Original attached to the original CQC Report and one copy attached to each copy;
- e. Field Test Reports: One copy, within [two working days][the week]after the test is performed, attached to the CQC Report;
- f. QC Meeting Minutes: One copy, within [two working days][the week]after the meeting; and
- g. QC Certifications: As required by the paragraph entitled "QC Certifications."

1.3 QC PROGRAM REQUIREMENTS

Establish a QC system of inspection and tests of the work and that of the subcontractors to ensure that all applicable requirements of the drawings and specifications are met. Be diligent to ensure that the quality of workmanship is satisfactory, that dimensional requirements are met, that defective materials are not used and that all required control and laboratory testing procedures (as stipulated under various divisions of

the specifications) are affected. Where specific testing procedures are not stipulated, establish and conduct a procedure to ensure adherence to specified quality. Make an initial inspection of each phase of work as soon as a representative portion has been completed, and make daily follow-up inspections, to ensure that an acceptable quality of work is established and maintained.

Where repetitive operations occur, erect representative portions in advance of main installation to ensure that quality is met, and that all parts fit together properly.

No program of testing (lab test or control test) set out hereinafter will relieve the Contractor of his responsibility to meet specified quality standards. Such tests in no way limit the Contractor from ordering or making such additional tests as deemed necessary to ensure contract compliance.

The QC program must cover on-site and off-site work and must be keyed to the work sequence. No work or testing may be performed unless the Contractor is on the work site.

1.3.1 Preliminary Work Authorized Prior to Acceptance

The only work that is authorized to proceed prior to the acceptance of the QC plan is mobilization of storage and office trailers, temporary utilities, and surveying.

1.3.2 Acceptance

Acceptance of the QC plan is required prior to the start of construction. The Contracting Officer reserves the right to require changes in the QC plan and operations as necessary, including removal of personnel, to ensure the specified quality of work. The Contracting Officer reserves the right to interview any member of the QC organization at any time in order to verify the submitted qualifications.

1.3.3 Notification of Changes

Notify the Contracting Officer, in writing, of any proposed change, including changes in the QC organization personnel, a minimum of seven calendar days prior to a proposed change. Proposed changes must be subject to the acceptance by the Contracting Officer.

1.4 QC PLAN

Submit a QC plan within 15 calendar days after receipt of Notice of Award.

1.5 COORDINATION AND MUTUAL UNDERSTANDING MEETING

During the Pre-Construction conference and prior to the start of construction, discuss the QC program required by this contract. The purpose of this meeting is to develop a mutual understanding of the QC details, including documentation, administration for on-site and off-site work, and the coordination of the Contractor's management, production and the QC personnel. At the meeting, the Contractor will be required to explain how three phases of control will be implemented for each DFO. Contractor's personnel required to attend must include the , project manager, and superintendent. Minutes of the meeting will be prepared by the Contractor and signed by both the Contractor and the Contracting

Officer. The Contractor must provide a copy of the signed minutes to all attendees. Repeat the coordination and mutual understanding meeting when a new **Project manager or Superintendent** is appointed.

1.6 QC MEETINGS

After the start of construction, the **Contractor** must conduct QC meetings once every two] weeks at the work site with the superintendent and the foreman responsible for the ongoing and upcoming work. The **Contractor** must prepare the minutes of the meeting and provide a copy to the Contracting Officer within two working days after the meeting. As a minimum, the following must be accomplished at each meeting:

- a. Review the minutes of the previous meeting;
- b. Review the schedule and the status of work and rework;
- c. Review the status of submittals;
- d. Review the work to be accomplished in the next two weeks and documentation required;
- e. Resolve QC and production problems (RFIs, etc.);
- f. Address items that may require revising the QC plan; and
- g. Review Accident Prevention Plan (APP).

1.7 SCOPE OF QUALITY CONTROL INSPECTION AND TESTING

1.7.1 Contractor's Control Testing:

To be performed by the Contractor and/or subcontractors at the site as specified under respective Sections. Submit a written record of each test indicating the date, location, result, etc. Except as approved, conduct all control tests in the Contracting Officer presence.

Where specific tests are required by this contract, the Contractor shall notify the TM/Contract Administrator at least 24 hours prior to testing. The Contractor shall turn in a test report, if required, to the TM/Contract Administrator as soon as possible. The Contractor shall not proceed with any work that would cover up the work being tested until the TM/Contract Administrator has approved the work being tested.

1.7.2 Code Tests:

Inspection and tests required by codes or ordinances shall be the responsibility of the Contractor, except as otherwise provided, and except as mandated by Chapter 17 of the International Building Code (IBC).

1.7.3 Laboratory Testing And Observations Generally

1.7.3.1 Scope:

Tests or related activity by an independent laboratory, geotechnical consultant or agency shall be made as specified, pursuant to Chapter 17 of the IBC, and/or upon any reasonable indication that portions of the work fail to meet specifications.

1.7.3.2 Lab Selection:

The Contracting Officer and will jointly select a qualified test lab or agency which meets Section 1703 of the IBC, and to which the Contractor has no reasonable objection.

1.7.3.3 Coordination:

The Contractor shall implement and coordinate the testing programs by providing pertinent extracts of specifications, by facilitating tests, by giving ample notice to the lab and (where specified) by taking field samples, shipping specimens, uncovering work, etc. as noted in individual Sections. The Contractor shall also notify the Contracting Officer when laboratory personnel are required to visit site to secure specimens.

1.7.3.4 Cost:

Except as otherwise stated the cost of sampling and testing will be divided as follows:

- a. Government shall pay laboratory fees for stipulated tests and procedures (including those mandated by IBC Chapter 17).
- b. Contractor shall pay for testing or retesting caused by apparent failure to meet specifications.
- c. Contractor shall furnish without extra cost, including molds, field curing packing and delivery charges, all samples required for testing purposes.
- e. Contractor shall pay for mix design service.
- f. Contractor shall pay for tests required by code or ordinance and not otherwise specified.
- g. Contractor shall be responsible for shop and plant test reports required of fabricators and manufacturers.
- h. Contractor shall pay cost of special inspections mandated by code for non-approved shop fabricators (see IBC Article 1704.2.2).

1.7.4 Testing & Observations Mandated By IBC Chapter 17

1.7.4.1 Reports & Authority:

Results of specified tests and observations shall be forwarded directly to the Contracting Officer, and the Contractor as soon as practical. Any discrepancies noted will be brought to the immediate attention of the Contractor and the Contracting Officer. Reports to Building Officials will be forwarded at intervals acceptable to these officials.

Test lab personnel will have no authority to order work or accept changes to mitigate deficiencies or to accommodate conditions that might be encountered.

1.7.4.2 Stipulated Tests & Procedures:

Required tests and observations are described under the Specification Section related thereto and under Chapter 17 of the IBC. Among others,

test procedures and observations are included under the following Sections:

Concrete, Reinforcing Steel, Mortar & Grout, Unit Masonry, Structural
Metal Framing, Mechanical, and Electrical

1.7.5 Miscellaneous Testing And QC Procedures

1.7.5.1 General:

Except as noted, costs will be paid as noted above.

Test reports shall be forwarded by lab directly to the Contracting
Officer; copies will be furnished to the Contractor by the Lab.

1.7.5.2 Masonry Mortars & Grouts

See Division 4 for tests and controls for masonry units, mortar and grout,
and not required by IBC Chapter 17.

1.7.5.3 Concrete Moisture Test:

See Division 9 for tests required on concrete surface prior to application
of finish surface.

1.8 SUBMITTAL REVIEW AND APPROVAL

Procedures for submission, review, and approval of submittals are
described in Section 01 33 00 SUBMITTAL PROCEDURES.

1.9 TESTING

Except as stated otherwise in the specification sections, perform sampling
and testing required under this contract.

1.9.1 Accreditation Requirements

Construction materials testing laboratories must be accredited by a
laboratory accreditation authority and will be required to submit a copy
of the Certificate of Accreditation and Scope of Accreditation. The
laboratory's scope of accreditation must include the appropriate ASTM
standards (i.e.; E 329, C 1077, D 3666, D 3740, E 543) listed in the
technical sections of the specifications. Laboratories engaged in
Hazardous Materials Testing must meet the requirements of OSHA and EPA.
The policy applies to the specific laboratory performing the actual
testing, not just the "Corporate Office."

1.9.2 Laboratory Accreditation Authorities

Laboratory Accreditation Authorities include the National Voluntary
Laboratory Accreditation Program (NVLAP) administered by the National
Institute of Standards and Technology, the American Association of State
Highway and Transportation Officials (AASHTO), International Accreditation
Services, Inc. (IAS), U. S. Army Corps of Engineers Materials Testing
Center (MTC), the American Association for Laboratory Accreditation
(A2LA), the Washington Association of Building Officials (WABO) (Approval
authority for WABO is limited to projects within Washington State), and
the Washington Area Council of Engineering Laboratories (WACEL) (Approval
authority by WACEL is limited to projects within the NAVFAC WASH and
Public Works Center Washington geographical area).

1.9.3 Capability Check

The Contracting Officer retains the right to check laboratory equipment in the proposed laboratory and the laboratory technician's testing procedures, techniques, and other items pertinent to testing, for compliance with the standards set forth in this contract.

1.9.4 Test Results

Cite applicable Contract requirements, tests or analytical procedures used. Provide actual results and include a statement that the item tested or analyzed conforms or fails to conform to specified requirements. If the item fails to conform, notify the Contracting Officer immediately. Conspicuously stamp the cover sheet for each report in large red letters "CONFORMS" or "DOES NOT CONFORM" to the specification requirements, whichever is applicable. Test results must be signed by a testing laboratory representative authorized to sign certified test reports. Furnish the signed reports, certifications, and other documentation to the Contracting Officer.

1.10 QC CERTIFICATIONS

1.10.1 Contractor Quality Control Report Certification

Each CQC Report must contain the following statement: "On behalf of the Contractor, I certify that this report is complete and correct and equipment and material used and work performed during this reporting period is in compliance with the contract drawings and specifications to the best of my knowledge except as noted in this report."

1.10.2 Invoice Certification

Furnish a certificate to the Contracting Officer with each payment request, signed by the Contractor, attesting that as-built drawings are current and attesting that the work for which payment is requested, including stored material, is in compliance with contract requirements.

1.10.3 Completion Certification

Upon completion of work under this contract, the Contractor must furnish a certificate to the Contracting Officer attesting that "the work has been completed, inspected, tested and is in compliance with the contract."

1.11 COMPLETION INSPECTIONS

1.11.1 Punch-Out Inspection

Near the completion of all work or any increment thereof established by a completion time stated in the Contract clause "Commencement, Prosecution, and Completion of Work," or stated elsewhere in the specifications, the Contractor must conduct an inspection of the work and develop a punch list of items which do not conform to the approved drawings and specifications. Include in the punch list any remaining items of the "Rework Items List", which were not corrected prior to the Punch-Out inspection. The punch list must include the estimated date by which the deficiencies will be corrected. A copy of the punch list must be provided to the Contracting Officer. The Contractor or staff must make follow-on inspections to ascertain that all deficiencies have been corrected. Once

this is accomplished, the Contractor must notify the Government that the facility is ready for the Government "Pre-Final Inspection".

1.11.2 Pre-Final Inspection

The Government and QC manager will perform this inspection to verify that the facility is complete and ready to be occupied. A Government pre-final punch list may be developed as a result of this inspection. The Contractor must ensure that all items on this list are corrected prior to notifying the Government that a "Final" inspection with the customer can be scheduled. Any items noted on the "Pre-Final" inspection must be corrected in a timely manner and must be accomplished before the contract completion date for the work or any particular increment thereof if the project is divided into increments by separate completion dates.

1.11.3 Final Acceptance Inspection

The Contractor, the superintendent, or other Contractor management personnel and the Contracting Officer will be in attendance at this inspection. Additional Government personnel may be in attendance. The final acceptance inspection will be formally scheduled by the Contracting Officer based upon results of the "Pre-Final Inspection". Notice must be given to the Contracting Officer at least 14 days prior to the final inspection. The notice must state that all specific items previously identified to the Contractor as being unacceptable will be complete by the date scheduled for the final acceptance inspection. Failure of the Contractor to have all contract work acceptably complete for this inspection will be cause for the Contracting Officer to bill the Contractor for the Government's additional inspection cost in accordance with the contract clause "Inspection of Construction".

1.12 DOCUMENTATION

Maintain current and complete records of on-site and off-site QC program operations and activities. The forms identified under the paragraph "INFORMATION FOR THE CONTRACTING OFFICER" must be used. Reports are required for each day work is performed. Account for each calendar day throughout the life of the contract. Every space on the forms must be filled in. Use N/A if nothing can be reported in one of the spaces. The superintendent and the Contractor must prepare and sign the Contractor Production and CQC Reports, respectively. The reporting of work must be identified by terminology consistent with the construction schedule. In the "remarks" section in this report which will contain pertinent information including directions received, problems encountered during construction, work progress and delays, conflicts or errors in the drawings or specifications, field changes, safety hazards encountered, instructions given and corrective actions taken, delays encountered and a record of visitors to the work site. For each remark given, identify the Schedule Activity No. that is associated with the remark.

1.12.1 Quality Control Validation

Establish and maintain the following in a series of three ring binders. Binders must be divided and tabbed as shown below. These binders must be readily available to the Government's Quality Assurance Team during all business hours.

- a. All completed Preparatory and Initial Phase Checklists, arranged by specification section.

- b. All milestone inspections, arranged by Activity/Event Number.
- c. A current up-to-date copy of the Testing and Plan Log with supporting field test reports, arranged by specification section.
- d. Copies of all contract modifications, arranged in numerical order. Also include documentation that modified work was accomplished.
- e. A current up-to-date copy of the Rework Items List.
- f. Maintain up-to-date copies of all punch lists issued by the QC Staff on the Contractor and Sub-Contractors and all punch lists issued by the Government.

1.12.2 As-Built Drawings

The Contractor shall provide to the Government marked drawings commonly referred to as "as-builts" indicating conditions that differ from that shown on the contract plans. The Contractor will review with the CO the "as-builts" as needed to ensure an accurate up-to-date set of documents is being kept. Changes are to be noted as the work progresses. The Contractor will utilize a Government-furnished copy of the contract drawings with the changes neatly indicated in red using the drafting standards and legends indicated in the contract drawings. One copy is required and will be submitted to the CO at the final inspection. If there are no changes, a title sheet (from the contract drawings) will only be required with the note "NO CHANGES" marked appropriately.

1.13 NOTIFICATION ON NON-COMPLIANCE

The Contracting Officer will notify the Contractor of any detected non-compliance with the foregoing requirements. The Contractor must take immediate corrective action. If the contractor fails or refuses to correct the non-compliant work, the Contracting Officer will issue a non compliance notice. Such notice, when delivered to the Contractor at the work site, must be deemed sufficient for the purpose of notification. If the Contractor fails or refuses to comply promptly, the Contracting Officer may issue an order stopping all or part of the work until satisfactory corrective action has been taken. The Contractor must make no part of the time lost due to such stop orders the subject of claim for extension of time, for excess costs, or damages.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

-- End of Section --

SECTION 01 50 00

TEMPORARY CONSTRUCTION FACILITIES AND CONTROLS

11/20, CHG 2: 08/22

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C511 (2017; R 2021) Reduced-Pressure Principle
Backflow Prevention Assembly

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (2023) National Electrical Code

NFPA 241 (2022) Standard for Safeguarding
Construction, Alteration, and Demolition
Operations

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1 (2014) Safety -- Safety and Health
Requirements Manual

1.2 SUBMITTALS

Government approval is required for submittals. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Construction Site Plan

Contractor Computer Cybersecurity Compliance Statements

Contractor Temporary Network Cybersecurity Compliance Statements

SD-06 Test Reports

Backflow Preventer Tests

SD-07 Certificates

Backflow Tester Certification

Backflow Preventers Certificate of Full Approval

1.3 CONSTRUCTION SITE PLAN

Prior to the start of work, submit for Government approval a site plan showing the locations and dimensions of temporary facilities (including

layouts and details, equipment and material storage area (onsite and offsite), and access and haul routes, avenues of ingress/egress to the fenced area and details of the fence installation. Identify any areas which may have to be graveled to prevent the tracking of mud. Indicate if the use of a supplemental or other staging area is desired. Show locations of safety and construction fences, site trailers, construction entrances, trash dumpsters, temporary sanitary facilities, and worker parking areas.

1.4 BACKFLOW PREVENTERS CERTIFICATE

1.4.1 Backflow Tester Certificate

Prior to testing, submit to the Contracting Officer certification issued by the State or local regulatory agency attesting that the backflow tester has successfully completed a certification course sponsored by the regulatory agency. Tester must not be affiliated with a company participating in other phases of this Contract.

1.4.2 Backflow Prevention Training Certificate

Submit a certificate recognized by the State or local authority that states the Contractor has completed at least 10 hours of training in backflow preventer installations. The certificate must be current.

1.5 DOD CONDITION OF READINESS (COR)

DOD will set the Condition of Readiness (COR) based on the weather forecast for sustained winds 50 knots (58 mph) or greater. Contact the Contracting Officer for the current COR setting.

Monitor weather conditions a minimum of twice a day and take appropriate actions according to the approved Emergency Plan in the accepted Accident Prevention Plan, EM 385-1-1 Section 01 Emergency Planning and the instructions below.

Unless otherwise directed by the Contracting Officer, comply with:

- a. Condition FOUR (Sustained winds of 58 mph or greater expected within 72 hours): Normal daily jobsite cleanup and good housekeeping practices. Collect and store in piles or containers scrap lumber, waste material, and rubbish for removal and disposal at the close of each work day. Maintain the construction site including storage areas, free of accumulation of debris. Stack form lumber in neat piles less than 3.3 feet high. Remove all debris, trash, or objects that could become missile hazards. Review requirements pertaining to "Condition THREE" and continue action as necessary to attain "Condition FOUR" readiness. Contact Contracting Officer for weather and COR updates and completion of required actions.
- b. Condition THREE (Sustained winds of 58 mph or greater expected within 48 hours): Maintain "Condition FOUR" requirements and commence securing operations necessary for "Condition ONE" which cannot be completed within 18 hours. Cease all routine activities which might interfere with securing operations. Commence securing and stow all gear and portable equipment. Make preparations for securing buildings. Reinforce or remove formwork and scaffolding. Secure machinery, tools, equipment, materials, or remove from the jobsite. Expend every effort to clear all missile hazards and loose equipment from general base areas. Contact Contracting Officer for weather and

COR updates and completion of required actions. Review requirements pertaining to "Condition TWO" and continue action as necessary to attain "Condition THREE" readiness.

- c. Condition TWO (Sustained winds of 58 mph or greater expected within 24 hours): Secure the jobsite, and leave Government premises.
- d. Condition ONE. (Sustained winds of 58 mph or greater expected within 12 hours): Contractor access to the jobsite and Government premises is prohibited.

1.6 CYBERSECURITY DURING CONSTRUCTION

{For Reference Only: This subpart (and its subparts) relates to AC-18, SA-3, CCI-00258.} Meet the following requirements throughout the construction process.

1.6.1 Contractor Computer Equipment

Contractor owned computers may be used for construction. When used, contractor computers must meet the following requirements:

1.6.1.1 Operating System

The operating system must be an operating system currently supported by the manufacturer of the operating system. The operating system must be current on security patches and operating system manufacturer required updates.

1.6.1.2 Anti-Malware Software

The computer must run anti-malware software from a reputable software manufacturer. Anti-malware software must be a version currently supported by the software manufacturer, must be current on all patches and updates, and must use the latest definitions file. All computers used on this project must be scanned using the installed software at least once per day.

1.6.1.3 Passwords and Passphrases

The passwords and passphrases for all computers must be changed from their default values. Passwords must be a minimum of eight characters with a minimum of one uppercase letter, one lowercase letter, one number and one special character.

1.6.1.4 Contractor Computer Cybersecurity Compliance Statements

Contractor personnel shall successfully complete, as a minimum, National Agency Check (NAC), before operating government furnished workstations that have access to Air Force e-mail systems. These investigations shall be submitted by the government at no additional cost to the contractor. The contractor shall comply with the DOD 5200.2-R, Personnel Security Program, and AFI 33-119, Electronic Mail (E-Mail) Management and Use, requirements.

Provide a single submittal containing completed Contractor Computer Cybersecurity Compliance Statements for each company using contractor owned computers. Contractor Computer Cybersecurity Compliance Statements must use the template published at <http://www.wbdg.org/ffc/dod/unified->

[facilities-guide-specifications-ufgs/forms-graphics-tables](#). Each Statement must be signed by a cybersecurity representative for the relevant company.

1.6.2 Temporary IP Networks

Temporary contractor-installed IP networks may be used during construction. When used, temporary contractor-installed IP networks must meet the following requirements:

1.6.2.1 Network Boundaries and Connections

The network must not extend outside the project site and must not connect to any IP network other than IP networks provided under this project or Government furnished IP networks provided for this purpose. Any and all network access from outside the project site is prohibited.

1.6.3 Government Access to Network

Government personnel, as defined, prescribed, and identified by the Contracting Officer, must be allowed to have complete and immediate access to the network at any time in order to verify compliance with this specification. Or if there is a Government agency that's responsible, identify that agency.

1.6.4 Temporary Wireless IP Networks

In addition to the other requirements on temporary IP networks, temporary wireless IP (WiFi) networks must not interfere with existing wireless network and must use WPA2 security. Network names (SSID) for wireless networks must be changed from their default values.

1.6.5 Passwords and Passphrases

The passwords and passphrases for all network devices and network access must be changed from their default values. Passwords must be a minimum 8 characters with a minimum of one uppercase letter, one lowercase letter, one number and one special character.

1.6.6 Contractor Temporary Network Cybersecurity Compliance Statements

Provide a single submittal containing completed Contractor Temporary Network Cybersecurity Compliance Statements for each company implementing a temporary IP network. Contractor Temporary Network Cybersecurity Compliance Statements must use the template published at <http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms-graphics-tables>. Each Statement must be signed by a cybersecurity representative for the relevant company. If no temporary IP networks will be used, provide a single copy of the Statement indicating this.

PART 2 PRODUCTS

2.1 TEMPORARY SIGNAGE

2.1.1 Bulletin Board

Prior to the commencement of work activities, provide a clear weatherproof covered bulletin board not less than **36 by 48 inches** in size for displaying the Equal Employment Opportunity poster, a copy of the wage

decision contained in the Contract, Wage Rate Information poster, Safety and Health Information as required by EM 385-1-1 Section 01 and other information approved by the Contracting Officer. Utilize the following website to access and download as appropriate EEO posters, Service Contract posters, and disability posters required in accordance with 52.222-26, 52.222-41, and 52.222-36 respectively. (<http://www.dol.gov/osbp/sbrefa/poster/main.htm>) Locate the bulletin board at the project site in a conspicuous place easily accessible to all employees, and in location as approved by the Contracting Officer.

2.1.2 Project Identification Signs

ALL construction projects that require outside storage or offices, trailers, etc. shall require a project board (sign). Project Board layout requirements will be included in the project specifications (01000 AA Project Board Template). The sign shall be at least 3' X 5' and no greater than 4' X 8'. The sign will be installed similar to 01000 AA Project Board Appendix A.

The requirements for the signs, their content, and location are as indicated. Erect signs within 15 days after receipt of the notice to proceed. Correct the data required by the safety sign daily, with light colored metallic or non-metallic numerals.

2.1.3 Warning Signs

Post temporary signs, tags, and labels to give workers and the public adequate warning and caution of construction hazards according to the EM 385-1-1 Section 04. Attach signs to the perimeter fencing every 150 feet warning the public of the presence of construction hazards. Signs must require unauthorized persons to keep out of the construction site. Correct the data required by safety signs daily. Post signs at all points of entry designating the construction site as a hard hat area.

2.2 TEMPORARY TRAFFIC CONTROL

2.2.1 Barricades

Furnish, place and maintain all required barricades as directed by the Safety Office and the STM/Contract Administrator. Access driveways and doors will remain clear at all times. Barricades are required whenever safe public access to paved areas such as roads, parking areas or sidewalks is prevented by construction activities or as otherwise necessary to ensure the safety of both pedestrian and vehicular traffic. Securely place barricades clearly visible with adequate illumination to provide sufficient visual warning of the hazard during both day and night.

2.3 TEMPORARY WIRING

Provide temporary wiring in accordance with EM 385-1-1 Section 11, NFPA 241 and NFPA 70. Include monthly inspection and testing of all equipment and apparatus.

Whenever the Contractor uses portable electrical tools or equipment in an outside location or in an interior wet location where floor is conductive such as concrete, the Contractor shall provide and use a portable ground fault circuit interrupter (GFCI). This shall apply wherever electric power is supplied through Government-controlled facilities. The Contractor shall be responsible for maintaining the GFCI in operating

condition and testing it before each use.

2.4 BACKFLOW PREVENTERS

Certificate of Full Approval from FCCCHR List, University of Southern California, attesting that the design, size and make of each backflow preventer has satisfactorily passed the complete sequence of performance testing and evaluation for the respective level of approval. Certificate of Provisional Approval is not acceptable.

Reduced pressure principle type conforming to the applicable requirements AWWA C511. Provide backflow preventers complete with [150 pound] [_____] flanged [cast iron],[ductile iron,] [bronze,][brass] mounted gate valve [and strainer], [304][_____] stainless steel or bronze, internal parts.

PART 3 EXECUTION

3.1 EMPLOYEE PARKING

Construction Contract employees must park privately owned vehicles in an area designated by the Contracting Officer. Employee parking must not interfere with existing and established parking requirements of the Government installation.

3.2 AVAILABILITY AND USE OF UTILITY SERVICES

3.2.1 Temporary Utilities

Provide temporary utilities required for construction. Materials may be new or used, must be adequate for the required usage, not create unsafe conditions, and not violate applicable codes and standards.

3.2.2 Sanitation

Provide and maintain within the construction area minimum field-type sanitary facilities in accordance with EM 385-1-1 Section 02. Locate the facilities behind the construction fence or out of the public view. Clean units and empty wastes at least once a week or more frequently into a municipal, district, or station sanitary sewage system, or remove waste to a commercial facility. Obtain approval from the system owner prior to discharge into a municipal, district, or commercial sanitary sewer system. Penalties or fines associated with improper discharge will be the responsibility of the Contractor. Coordinate with the Contracting Officer and follow station regulations and procedures when discharging into the station sanitary sewer system. Maintain these conveniences at all times. Include provisions for pest control and elimination of odors. Government toilet facilities will not be available to Contractor's personnel.

3.2.3 Telephone

Make arrangements and pay all costs for telephone facilities desired.

3.2.4 Fire Protection

Provide temporary fire protection equipment for the protection of personnel and property during construction. Remove debris and flammable materials daily to minimize potential hazards.

3.3 REDUCED PRESSURE BACKFLOW PREVENTERS

Provide an approved reduced pressure backflow prevention assembly at each location where the Contractor taps into the Government potable water supply.

Perform [backflow preventer tests](#) using test equipment, procedures, and certification forms conforming to those outlined in the latest edition of the Manual of Cross-Connection Control published by the FCCCHR Manual. Test and tag each reduced pressure backflow preventer upon initial installation (prior to continued water use) and monthly thereafter. Tag must contain the following information: make, model, serial number, dates of tests, results, maintenance performed, and signature of tester. Record test results on certification forms conforming to requirements cited earlier in this paragraph.

3.4 CONTRACTOR'S TEMPORARY FACILITIES

The Contractor will be provided space as indicated for an office trailer and a 6 foot wood fence with lockable gates around the staging of materials in support of this project and must provide protection and security for it in that area.

Contractor is responsible for security of their property. Provide adequate outside security lighting at the temporary facilities. Trailers must be anchored to resist high winds and meet applicable state or local standards for anchoring mobile trailers. Coordinate anchoring with [EM 385-1-1](#) Section 04. The Contract Clause entitled "FAR 52.236-10, Operations and Storage Areas" and the following apply:

3.4.1 Appearance of Trailers

- a. Trailers must be roadworthy and comply with all appropriate state and local vehicle requirements. Trailers which are rusted, have peeling paint or are otherwise in need of repair will not be allowed on Installation property. Trailers must present a clean and neat exterior appearance and be in a state of good repair.
- b. Maintain the temporary facilities. Failure to do so will be sufficient reason to require their removal at the Contractor's expense.

3.4.2 Safety Systems

Protect the integrity of all installed safety systems or personnel safety devices. Obtain prior approval from the Contracting Officer if entrance into systems serving safety devices is required. If it is temporarily necessary to remove or disable personnel safety devices in order to accomplish Contract requirements, provide alternative means of protection prior to removing or disabling any permanently installed safety devices or equipment and obtain approval from the Contracting Officer.

3.4.3 Weather Protection of Temporary Facilities and Stored Materials

Take necessary precautions to ensure that roof openings and other critical openings in the building are monitored carefully. Take immediate actions required to seal off such openings when rain or other detrimental weather is imminent, and at the end of each workday. Ensure that the openings are completely sealed off to protect materials and equipment in the building from damage.

3.4.3.1 Building and Site Storm Protection

When a warning of gale force winds is issued, take precautions to minimize danger to persons, and protect the work and nearby Government property. Precautions must include, but are not limited to, closing openings; removing loose materials, tools and equipment from exposed locations; and removing or securing scaffolding and other temporary work. Close openings in the work when storms of lesser intensity pose a threat to the work or any nearby Government property.

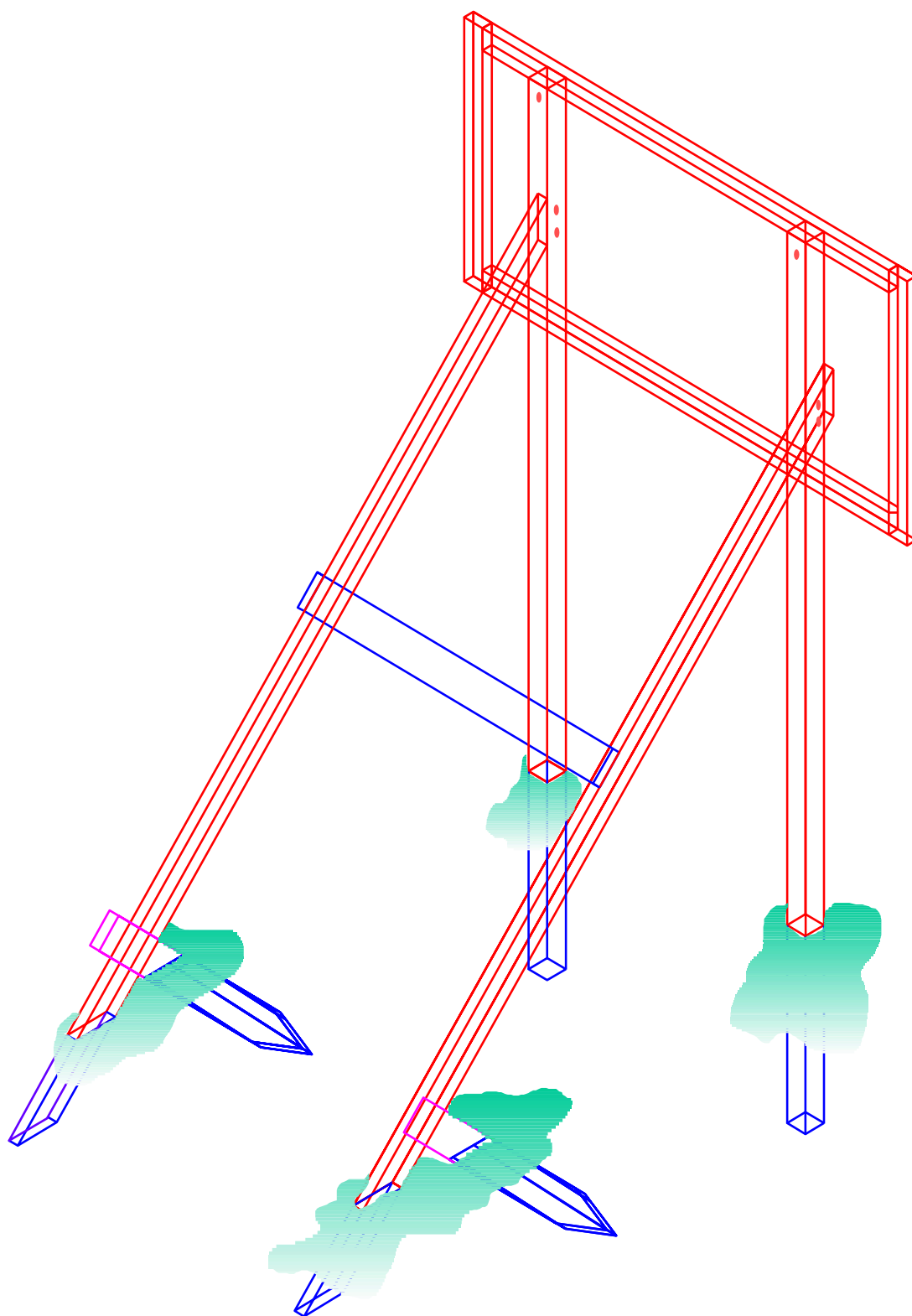
3.5 CLEANUP

At the end of each working day the Contractor shall clean up the work site which includes the construction area(s), construction office area(s), material storage area(s), parking and eating area(s), and any other area(s) affected by the construction process. Stacked material shall not be within 8m (25-feet) of an active roadway. Tracking of soil, mud or other construction debris or substance on any Base street, parking area, sidewalk, patio, driveway, turf, or other area shall not be permitted. In accordance with "The Maxwell Landscape Management Operational Instruction Manual," the Contractor shall keep all turfed areas mowed and clean within the construction limits, and shrubs and other elements in the landscape shall be maintained.

3.6 RESTORATION OF STORAGE AREA

Upon completion of the project remove the bulletin board, signs, barricades, haul roads, and all other temporary products from the site. After removal of trailers, materials, and equipment from within the fenced area, remove the fence. Restore areas used during the performance of the Contract to the original or better condition. Remove gravel used to traverse grassed areas and restore the area to its original condition, including top soil and seeding as necessary.

-- End of Section --





PROJECT # OR WO #
REPLACE AIR HANDLER UNITS B/144
PROJECT USER OR REQUESTER – 42 FSS OR LEMAY CENTER
(no names or contact info)



PROJECT MANAGER – (NAME, PHONE #, EMAIL)
GOVERNMENT POC - (COR (NOT CONS) NAME, PHONE #, EMAIL)
CONTRACTOR PERFORMING WORK - ABC AIR CONDITIONING COMPANY
EXECUTION AGENT – (42CONS etc)

SCOPE OF PROJECT – EXAMPLE – REPLACE 5 AIR HANDLER UNITS. WORK
PRIMARYLY TO BE PERFORMED IN MECHANICAL ROOM OR ON ROOF.

ESTIMATED START DATE – XX XXX 2020
ESTIMATED COMPLETION DATE –XX XXX 2020

IF THERE IS A PROBLEM OR QUESTION CONTACT
PRIMARY (name, phone #, email) (Contract Manager Name)
ALTERNATE (name, phone #, email)

SECTION 01 57 13

STORMWATER PROTECTION BEST MANAGEMENT PRACTICES
04/23

PART 1 GENERAL

1.1 ADMINISTRATIVE REQUIREMENTS

1.1.1 SITE DISTURBANCE DURING CONSTRUCTION ACTIVITIES & STORMWATER
POLLUTION PREVENTION

1.1.1.1 Permitting:

National Pollutant Discharge Elimination System (NPDES) - For any project that will disturb an area "equal to" or "more than" 1 acre, the subcontractor is required to submit an ADEM Notice of Intent (NOI) under the NPDES General Construction Permit. A completed copy of the NOI must be submitted to the Contract office and Environmental Department prior to any site work. The "site" encompasses the collective area of disturbance for any project, even if the disturbed areas are non-contiguous. The subcontractor is responsible for all required inspections under ADEM's NPDES General Permits. However, Base Environmental will perform additional oversight inspections and instruct changes, alterations and/or modifications as necessary.

1.1.1.2 Best Management Practices (BMPs): Permitted and Non-Permitted
Projects

The subcontractor shall use industry-recognized Best Management Practices (BMPs) to the maximum extent practical to avoid and control stormwater runoff from the construction site and any temporary roads that may be used to access the site (entrances/exits). Subcontractor shall perform all work under this contract in such a manner that no pollutants of any kind are released into ditches, storm drains, streams, lakes, or other surface waters on or connected to the site. BMPs shall be implemented prior to site disturbance and maintained throughout project duration until permanent stabilization has been achieved. Provide protective measures as described below.

1.2 SUBMITTALS

Government approval is required for submittals. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION

3.1 Best Management Practice Protective Measures

Provide the following measures for Storm Water Protection which shall include, but are not limited to:

- A. Silt Fencing: Install silt fencing around all storm drains and runoff channels that can be potentially impacted by the construction/demolition activity. Install silt fencing where appropriate and to the maximum extent necessary to prevent removal of

particulates and debris with runoff from the site. Refer to the ADEM Handbook for Type A, B and C methods.

- B. **Wattles:** Install wattles in front of curb inlets that will be impacted when sediment run-off is inevitable due to tracking, equipment and supply staging areas and/or other disturbed areas. Wattles shall be in lengths that cover entire inlet opening. Base Environmental does not recommend blocking curb/street inlets unless absolute necessary. Blocking street inlets will cause temporary ponding which may impact traffic flow. The contractor must make all reasonable attempts to maintain sediment on the construction site to eliminate having to protect street inlets. Wattles are an acceptable practice when protecting drop inlets located in landscaped areas where stakes can be used to hold the wattles in place on a disturbed construction site. Straw wattles shall not be used for drop inlet protection on concrete or asphalt pavement areas.
- C. **Silt Savers:** Install silt savers as a primary means for drop inlet protection within the disturbed areas of a construction site. Silt savers come in round or square molds depending on the drop inlet configuration and size. Crushed stone and/or soils shall be used to support the mold and filter fabric in place. Install as per manufacture recommendations.
- D. **Hay Bales:** Place and stake hay bales or other temporary dams where appropriate for impeding stormwater flow across large, open areas of disturbed earth and as particulate barriers to prevent erosion and unintended soil relocation. Hay bales shall not be used as a sole source when protecting drop inlets. Silt fencing and/or crushed stone shall be used in support with hay bales to prevent entry of sediment and any construction debris during the activity. Hay bales shall not be used to protect curb inlets.
- E. **Block and Gravel:** Install block and gravel inlet protection where an impermeable surface (concrete, asphalt, etc.) exists around the drain and in other areas where this type protection is more appropriate to prevent particulate transport to the inlet. The height of the block and gravel inlet structure shall be a minimum of 12 inches. A geotextile fabric shall also be placed as a filter between the block and crushed stone (ALDOT #57 crushed stone or similar grade shall be used).
- F. **Geotextile Fabric (drop inlet barriers):** The contractor may use a non-woven geotextile fabric as a means to protect drop inlets with metal grates. The drop inlet grate can be removed in order to place a sufficient amount of geotextile fabric inside the storm inlet opening. The grate must be replaced on top of the fabric maintaining a tight fit with no gaps in order to provide a sock-like barrier. Excess fabric shall drape outside the grate allowing for any sediment to be captured. This method allows for construction traffic but must be maintained. Sediment overloaded geotextile fabric must be cleaned and replaced as needed.
- G. **Stabilization:** All disturbed and exposed soils shall be preserved, covered if needed, in a manner that prevents soil migration with rainfall or runoff. Subcontractor is responsible for repair of any erosion caused by the subcontractor's construction activities. All disturbed or exposed soil shall be permanently stabilized at the earliest practicable date. In most cases, seeding is not allowed on

the installation; areas shall be repaired with sod, re-vegetation shall be with non-invasive plants that are native species or approved turf species.

- H. Concrete & Asphalt Saw-Cutting: The contractor shall implement means and methods to control and clean-up from saw-cutting activities immediately and not allow for traffic to travel through the saw cut locations until the "saw-cut mud" clean-up activities are completed. Washing into the nearest storm drain is prohibited.
- I. Concrete Wash-Outs: The contractor must have a location on site or at an approved location by the 42d CE Project Manager/STM where concrete trucks can wash out. The location must be in an area that will not allow the wastewater to flow or drain into storm inlets, drainage ditches, waterways or roadways. For large projects where multiple concrete placements will be performed, a wash out location must be designated and protected. Typically, this is created by using a soil berm and combining with the use of hay bales, silt fencing, and/or wattles.
- J. Materials & Fuels Storage: The contractor must maintain a clean and orderly project site and laydown yard with regards to materials storage. Containers with liquids, oils, lubricants, fuels and other materials must be properly covered and/or stored on site and protected from rainfall and inclement weather. Spill prevention controls and spill response materials must be available and/or on hand in case of a spill. Base Environmental must be notified of any spill for documentation, instructions for clean-up and disposal requirements.
- K. Soil, Sand and Crushed Stone Stock Piles: The contractor must store stock piles in a manner and in a location where sediment run-off will not leave the site. Storm inlets must be protected in affected or in adjacent areas with the use of silt fencing, wattles, berms and/or a combination of thereof, unless sediment control can be maintained on site.
12. Dust Control: Water shall be used in a manner to control dust during dry periods of the year and continuous demolition activities. The amount of water used shall be monitored by the subcontractor. Excess water can create additional problems.
- L. Construction Entrances/Exits Pads: The contractor shall construct an adequate construction entrance/exit pad to protect from vehicle and construction equipment tracking onto roadways, parking lots and other impermeable hard surfaces. A layer of non-woven geotextile fabric shall be placed in a designated location(s) for the project. ALDOT #1 crushed stone shall be placed with a minimum thickness of 6 inches on the fabric. The pad must be constructed to an adequate length and width for the project traffic and equipment. The contractor shall not use crusher run, river gravel, or small crushed stone such as ALDOT #57 or #67 stone. This material compacts and thus does not provide an adequate surface for flexing rubber tires to remove mud and sediment. It is the responsibility of the subcontractor to maintain and replace the crushed stone when conditions do not provide adequate protection from off-site tracking.

3.2 ENFORCEMENT MECHANISM - CONSTRUCTION SITE STORM WATER RUNOFF CONTROL

All project sites will be subject to inspections by CEIE and/or CE project managers. Documenting inspections and non-compliance issues will occur on

monthly summary reports to the Government Quality Assurance Evaluator (QAE) for Maxwell AFB.

If site condition(s) warrants an instruction for correction or implementation of a BMP, this item will be verbally discussed between the subcontractor's representative, the CEIE representative and the CE project manager. Instructions will be given if a site condition is, or has the potential to become, a NPDES non-compliance issue. The subcontractor will be given a deadline by which to implement, change and/or fix the issue, depending on the finding.

A follow up inspection by CEIE or the CE project manager will be performed to observe for site corrections. If the site correction has not been implemented or fixed due to a lack of effort, lack of concern or subcontractor negligence, then a written warning will be documented and placed on file. The subcontractor will be given a warning letter and a final deadline for implementing the mandatory instruction.

If, on a 2nd follow up site inspection, the subcontractor has not completed the Base's instruction, a work stoppage, at the subcontractor's loss of time, will be enforced until the compliance issue or issues have been addressed.

If more than one work stoppage has to be enforced for a single project, due to non-compliance issues, the general subcontractor will be subject to removal from all future bid lists for a time determined by the Subcontract Administrators.

The above process can be used as guidance for all projects. However, CEIE and CE reserve the right to work with subcontractors on a project-to-project basis, based on special conditions. Special conditions may be determined by CEIE and CE. Special conditions may include, but are not limited to, situations such as the following:

- A. Unforeseen weather conditions. (i.e., flooding, severe thunderstorms with significant rainfall events, etc....)
- B. Vandalism
- C. Subcontractor making continuous efforts to comply with standards, using means and methods typically applied in the construction industry, and exhibiting an overall concern with maintaining a site in compliance with the Base and under State guidelines.

A maintenance plan should be developed to address issues that need immediate corrections, which may result in off-site discharges, when the subcontractor is not on Base, refuses to return in a timely manner to make corrections and/or cannot be contacted. These issues include, but are not limited to, the following: silt fence repair, street sweeping, inlet protection, etc.... The cost of these corrections could be passed on to the subcontractor, if the subcontractor is found to be at fault due to negligence.

-- End of Section --

SECTION 01 67 00.10

RECYCLED / RECOVERED MATERIALS – MAXWELL AFB

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

40 CFR 247 Comprehensive Procurement Guideline for Products Containing Recovered Material

1.2 OBJECTIVES

Government procurement policy is to acquire, in a cost effective manner, items containing the highest percentage of recycled and recovered materials practicable consistent with maintaining a satisfactory level of competition without adversely affecting performance requirements or exposing suppliers' employees to undue hazards from the recovered materials. The Environmental Protection Agency (EPA) has designated certain items which must contain a specified percent range of recovered or recycled materials. EPA designated products specified in this contract comply with the stated policy and with the EPA guidelines. The Contractor shall make all reasonable efforts to use recycled and recovered materials in providing the EPA designated products and in otherwise utilizing recycled and recovered materials in the execution of the work.

1.3 EPA DESIGNATED ITEMS INCORPORATED IN THE WORK

Various sections of the specifications contain requirements for materials that have been designated by EPA as being products, which are or can be made with recovered or recycled materials. These items, when incorporated into the work under this contract, shall contain at least the specified percentage of recycled or recovered materials unless adequate justification (non-availability) for non-use is provided. When a designated item is specified as an option to a non-designated item, the designated item requirements apply only if the designated item is used in the work.

1.4 EPA PROPOSED ITEMS INCORPORATED IN THE WORK

The items listed below have been identified by EPA as being products which are still being researched and are being considered for future Comprehensive Procurement Guideline (CPG) designation. It is recommended that these items, when incorporated in the work under this contract, contain the highest practicable percentage of recycled or recovered materials, provided specified requirements are also met.

EPA ITEMS CONSIDERED FOR CPG III DESIGNATION

- Carpet Runners
- Flooring Materials
- Hardboard
- Medium Density Fiberboard
- Nylon Carpet
- Particleboard
- Interior Trim and Window Frames
- Roofing Materials
- Rubberized Asphalt
- Building Blocks

Decking Material
Plastic Pipe
Aggregates
Concrete Containing Silica Fume

1.5 EPA LISTED ITEMS USED IN CONDUCT OF THE WORK BUT NOT INCORPORATED IN THE WORK

There are many products listed in 40 CFR 247 which have been designated or proposed by EPA to include recycled or recovered materials that may be used by the Contractor in performing the work but will not be incorporated into the work. These products include office products, temporary traffic control products, and pallets. It is recommended that these non-construction products, when used in the conduct of the work, contain the highest practicable percentage of recycled or recovered materials.

<u>PRODUCT</u>	<u>MATERIAL</u>	<u>POSTCONSUMER CONTENT (%)</u>	<u>RECOVERED MATERIALS CONTENT (%)</u>
BUILDING INSULATION			
Rock Wool	Slag	--	75
Fiberglass	Glass Cullet	--	20-25
Cellulose Loose-Fill and Spray-On	Postconsumer Paper	75	75
Perlite Composite Board	Postconsumer Paper	23	23
Plastic Rigid Foam, Polyisocyanurate/ Polyurethane:			
Rigid Foam	--	--	9
Foam-in-Place	--	--	5
Glass Fiber Reinforced	--	--	6
Phenolic Rigid Foam	--	--	5
Plastic, Non-Woven Batt	Recovered or Postconsumer Plastics	--	100

NOTES: 1. Recovered materials content levels are based on the weight (not volume) of materials in the insulation core only.

2. Glass cullet in fiberglass insulation shall conform to ASTM D5359.

<u>PRODUCT</u>	<u>MATERIAL</u>	<u>POSTCONSUMER CONTENT (%)</u>	<u>RECOVERED MATERIALS CONTENT (%)</u>
CEMENT AND CONCRETE			
Concrete	Coal Fly Ash	--	*As Specified
	Blast Furnace Slag	--	*As Specified

* Content depends upon the design - See Section 03300

<u>PRODUCT</u>	<u>MATERIAL</u>	<u>POSTCONSUMER CONTENT (%)</u>	<u>RECOVERED MATERIALS CONTENT (%)</u>
REPROCESSED AND CONSOLIDATED LATEX PAINTS			
Reprocessed Latex Paint			
White, off-white			
Pastel Colors		20	20
Grey, brown, earth tones			
and other dark colors		50-99	50-99
Consolidated Latex Paint		100	100

NOTE: Percentages apply to reprocessed latex paints used for interior and exterior architectural applications such as wallboard, ceilings, and trim; gutter boards; and concrete, stucco, masonry, wood, and metal surfaces. Percentages apply to consolidated latex paints used for covering graffiti, where color and consistency of performance are not primary concerns.

<u>PRODUCT</u>	<u>MATERIAL</u>	<u>POSTCONSUMER CONTENT (%)</u>	<u>RECOVERED MATERIALS CONTENT (%)</u>
FIBERBOARD / PAPERBOARD			
Structural fiberboard			80-100
Paminated paperboard	Post Consumer Paper	100	100

NOTES: 1. Content levels are based on the weight (not volume) of materials in the insulating core only.
2. Structural fiberboard containing recovered paper shall conform to ASTM C 208.

<u>PRODUCT</u>	<u>MATERIAL</u>	<u>POSTCONSUMER CONTENT (%)</u>	<u>RECOVERED MATERIALS CONTENT (%)</u>
HYDRAULIC MULCH			
Paper based hydr. Mulch	Paper	100	100
Wood based hydr. Mulch	Wood and Paper	100	

NOTE: Content levels are based on the dry weight of the fiber, exclusive of any dyes, wetting agents, seeds, fertilizer, or other non-cellulose additives.

END OF SECTION

SECTION 01 73 00

ALTERATION WORK
04/23

PART 1 GENERAL

1.1 SCOPE OF WORK

1.1.1 General Requirements

It is the intention of this Work that all required items will be built into new work such that cutting and patching is not required. Coordinate the work of all trades to achieve this end.

Where work is to be installed in the existing work to remain, the installation shall be made in the neatest practical manner which causes the least damage to the structure and to the finished surfaces, and which will produce the neatest result.

Patch all surfaces (interior and exterior) (with matching materials) where noted, where damaged by construction work, where new devices are installed in or on surface, where existing equipment or construction is removed, and where existing defects become permanently exposed as a result of operations.

Repair and patch all existing holes, tears, breaks, etc. in existing floors walls, and ceilings of rooms which are affected by this work.

Refer to mechanical and electrical drawings for additional work which will require patching, reworking ceilings, painting, etc.

Where results of demolition work will not be exposed, surfaces and elements must be structurally restored.

1.1.2 General Restoration and Patching:

Where damage is caused to existing lawns, shrubbery, walks, paving, utilities, mechanical and electrical systems, building elements, etc., which are to remain, restore to as good a condition as existed before work was begun. Report to the Architect and Contracting Officer any defect of existing work that is to be altered or extended. Before work is started in any area, conduct a thorough survey with the Architect and Contracting Officer, and furnish a report listing all defects of any type which are not otherwise required to be corrected; assume responsibility for any damage not reflected by the survey.

Perform demolition so as to avoid hazards to persons and property and to minimize interference with use of adjacent areas, interruption of utilities. Refer to Section 02 41 00 for Selective Demolition requirements. Provide adequate safeguards including warning signs, barricades, temporary fences, etc. to protect Owner and Contractor's personnel and the public. Refer to Section 01 50 00 for safeguard requirements.

1.2 DEFINITIONS

Enter text here.

1.3 ADMINISTRATIVE REQUIREMENTS

1.3.1 Coordination

Coordinate depth, location and connection of roof drain, underdrain, storm drain and sanitary pipe stub-outs. See Plumbing, Mechanical and Electrical Drawings for related work not shown on site drawings.

Assume indicated inverts are approximate only; verify before proceeding with work. Determine exact location and flow line at connection point of existing lines before constructing work affected thereby.

Schedule and conduct all operations to minimize soil erosion. Methods may include temporary construction of berms, dikes, slopes, drains, sedimentation basins, or other means to permit storm runoff with a minimum of erosion and sedimentation.

Schedule and coordinate in advance all outages of power, water, gas etc. Hold such outages to the minimum practical. Refer to Section 01 14 00 for additional requirements for "Utility Cutovers and Interruptions".

Where fresh air intakes of existing air units are adjacent to construction activity, such intakes shall be closed until the activity in that area has been completed. Thereafter reopen.

In existing construction, coordinate all work with sub-contractors, make minor adjustments in layout of various utilities and plan work ahead of time to avoid conflicts and produce a workable system.

Do not allow debris to accumulate; keep grounds as reasonably neat as practical; take special care near entrances and other areas frequented by public and visitors. Refer to Section 01 74 19 for additional requirements.

1.4 QUALITY CONTROL

1.4.1 Dimensions and Layout:

Dimensions on plan are nominal, verify exact widths from details and schedules. Unless dimensioned, locate door openings and other items by scale. Adjust to masonry coursing to avoid obstructions, etc. upon approval. Except as shown otherwise, new work shall line with and match existing. Assume all dimensions extended from existing work are approximate only.

1.4.2 Life Safety:

During construction, all existing fire exits, and fire protection systems must be continuously maintained unless other measures of equivalent safety are taken.

1.4.2.1 Fire Protection:

During construction, continuously maintain all existing fire exits and fire protection systems unless other measures of equivalent safety are taken.

In work areas, protect any existing smoke detectors with plastic bags so that construction dust does not send false signals; remove covers as soon

as work in that area is complete.

1.5 PROJECT/SITE CONDITIONS

Drawings reflect approximate existing conditions.

Minor discrepancies will not relieve the Contractor from completing the work in accordance with the intent set forth. Except as indicated otherwise, new work shall align with, match and work out with existing.

1.5.1 Existing Site Conditions:

Minor discrepancies shall not relieve the Contractor from completing the work in accordance with the intent set forth.

1.5.2 Existing Trees and Shrubs:

Box and protect from damage all trees and shrubs to remain which are within 25 feet of any construction activity; remove protection device upon completion of the project.

Prune as necessary limbs and branches of trees to remain, to clear building, pedestrian and vehicular traffic and drivers' sight distance at intersections.

1.5.3 Land Use Control Implementation Plan

Refer to the attached Land Use Control Implementation Plan (W9128F-10-D-0070 Task Order #007) dated August 2015 for environmental risks and responsibilities regarding the existing site.

1.5.4 Existing Utilities:

Remove storm pipes to be abandoned where they occur under new structures and 5 feet beyond. Leave all other abandoned storm pipe in place and plug all open ends solid with concrete.

1.5.5 Existing Equipment:

Upon proper notice the current building occupants will remove all loose personal items.

The Government will remove all projectors, associated cabling, wires to the A/V patch-panel, computers, display screens, smart board, etc; store them; hook them back up and test them for serviceability.

All other existing equipment will be the responsibility of the Contractor to remove, protect and store until construction is complete unless indicated otherwise. After construction is completed, all items must be moved back in-place by the Contractor. Contractor must protect all items from damage, dust, dirt, etc. If items require disconnecting and reconnecting the Contractor will be responsible for connections. If such items cannot be removed the Contractor will be responsible for protecting these items in place during construction.

Reinstall (rework if required) any brackets, braces, attachments, etc. of items to remain, and which were disturbed as a result of alterations.

Where sensitive equipment (i.e., computers, electronic equipment, etc.)

are to remain and operating, use extreme caution. Take steps to ensure that power will not be interrupted without prior knowledge of the Contracting Officer. Do not allow dust, heat or impact to damage units.

1.5.6 Asbestos Contamination:

In the event that existing asbestos insulation, fireproofing, flashings, ceilings, etc. are encountered and must be disturbed as a result of this work, the Contractor shall remove any and all hazardous materials in a proper and safe manor as required by ADEM. See Section 13279A for further requirements.

1.5.6.1 Notification of Lead Removal:

(Per Rule 406, any remodeling of an occupied building older than 1978 requires contractor to notify all occupants, give pamphlets, get receipts.)
Sub Title

Text

PART 2 PRODUCTS

2.1 MATERIALS

All materials shall be new except as specifically noted otherwise. Refer to individual Sections for material specification requirements.

Provide temporary lighting for the work area and protected exit path.

PART 3 EXECUTION

3.1 EXAMINATION

Before proceeding, examine details of new and finish work to be accommodated by demolition operations, in order to determine the appropriate scope, method of cutting, exact location, etc.

Where damage is caused to existing lawns shrubbery, walks, paving, utilities, mechanical and electrical systems, etc. restore to as good a condition as existed before work was begun. Report any defect of existing work that is to be altered or extended. Before work is started in any area, conduct a thorough survey with the Contracting Officer and furnish a report listing all defects of any types which are not otherwise required to be corrected.

3.2 PREPARATION

Where beams or bearings are cut, provide adequate shoring until the area is restored structurally.

Where the walls, etc. are cut or temporarily opened in the conduct of the work, the contractor shall take all precautions and implement temporary measures as required to protect the interior of the structure thus exposed from the elements and from vandalism.

Where existing concrete walks are cut, break back to the nearest tooled joint.

3.3 CUTTING RESTORATION AND PATCHING

3.3.1 GENERAL PATCHING REQUIREMENTS

Repair and patch all existing holes, tears, breaks, etc. in existing floors and walls of all rooms which are listed on the finish schedule.

Refer to Sprinkler, Mechanical and Electrical Drawings for additional work which will require patching, reworking ceilings, painting, etc.

Where results of demolition work will not be exposed, surfaces and elements must be only structurally restored.

Small holes of 4 sq in or less in masonry units may be patched with pointing grout. Where larger holes occur, cut out masonry unit and replace.

Where existing devices or utilities are removed from stone, fill voids with stone patching compound as specified.

Where cut edges of existing concrete work will be exposed in finished work, carefully patch to true line with epoxy grout.

Where an item is scheduled for reuse, clean and touch-up rust spots. Remove extraneous hasps, nails, signs, etc. Tighten up bolts, screws, etc.

Unless otherwise noted, match existing color, pattern and gloss of such surfaces as are replaced, patched, recoated, extended, altered, furred, etc.

Patch all openings in existing roofing membranes, which are caused as a result of this work. Rework and replace damaged rigid insulation with new material of same type and thickness as occurs.

Paint all existing previously painted surfaces where modified, soiled or damaged as a result of this work. Paint such surfaces corner-to-corner, or up to other natural break in the surface.

3.3.2 New Openings:

Patch all surfaces (Interior and Exterior) with matching materials where damaged by construction work, where new devices are installed in or on surface, where existing equipment or construction is removed, and where existing defects become permanently exposed as a result of operations.

Where new ducts or pipes pass through existing walls, floors, etc., and where doors are added, cut openings, build in new lintels and sleeves, etc. as required; rework walls at jambs, sills, etc. to finish the opening in a quality equal to that found. Where openings are cut in existing roof deck, carefully avoid damage to joists, beams, etc. unless cutting of such member is specifically noted.

Where ducts, piping, conduit, etc. penetrate existing floors, fire walls, etc., carefully build back work to surround duct or pipe to make wall fire and smoke tight (wall opening must not be over 1/2 inch larger than passing utility on any side).

Where an existing jamb or head is cut away and where a new opening is cut,

new brickwork shall tooth into existing work. New mortar joints shall match existing in tooling and width.

3.3.3 Furring:

Except where specifically indicated to be exposed, all new vertical and horizontal ducts, pipe, conduit, etc. (whether shown or not) in finished rooms or areas, and not encased in masonry or plaster construction, shall be furred in with noncombustible materials matching room finish. Existing mechanical and electrical work uncovered in alteration work shall be refurred.

Dimensions of horizontal furring and vertical chases shown for electric panels, ducts and/or pipes are nominal. Exact dimensions shall be determined by actual installation to suit field conditions, making allowances to clear columns, beams and other obstructions. Unless directed otherwise, or unless a design relationship is involved, hold such furrings etc. to the minimum practical size.

3.3.4 Wall Heights:

Unless otherwise noted, all walls shall extend to and seal against the gypsum board fire ceiling or deck above. Seal around all beams, joists, trusses, etc. that extend through these walls. Seal voids per specification Section 07 24 00. See ceiling plan for exceptions.

3.3.5 Floor Slopes:

Unless otherwise noted, floor slopes shall be 1.5 percent. Slope topping or setting bed where occurs. Where no topping or setting bed occurs, slope structural slab.

3.3.6 Existing Floors:

- A. Where existing hard tile or concrete topping occurs, remove tile, setting bed and/or topping and provide concrete topping to align with existing floor elevation (where floor drains occur, slope topping to drain). See Finish Schedule for finish to be applied over topping. Exercise caution in connection with removal of concrete topping, and of hard tile setting bed, to insure that structural concrete to remain is not damaged. Do not employ jackhammer without approval of specific technique proposed.
- B. Where existing concrete floor slabs-on-grade are cut for installation of new plumbing work, new footings, etc., take care to avoid damage to adjacent construction. Concrete patch shall be at least as thick as the existing slab and be reinforced with 6 x 6 #10/10 mesh. Finish to match existing surface. Reconstruct slab expansion joints, etc. which crossed trench.
- C. Where slabs above grade are removed, saw cut slabs at perimeter on center-line of bar joist, beam, etc. to allow for bearing of old and new slab.
- D. Make earth excavation as required below slab as small as will facilitate installation of new work. Shore sides if necessary to insure that earth under adjacent existing slab retains its compaction.
- E. Where a trench must pass under a footing, make excavation as small as

will accommodate the pipe.

- F. Backfill where required with carefully selected granular material working in 8 inch lifts with mechanical tampers.
- G. Where existing walls are removed, level and/or grind the floor to provide a surface for the new finish (see Finish Schedule).
- H. Where new floor finishes are scheduled or noted, remove existing resilient tile, vinyl and carpet finishes. Acid etch or grind existing concrete floor slab as required to remove grease, coating, etc. to receive new finish.
- I. Where new floor finishes are scheduled or noted, apply leveling compound where adjacent slab sections are not at proper level (achieve transition at rate not greater than 1/8 inch in 12 inches. Rake out slab-to-slab expansion joints (and similar conditions) 3/4 inch deep and fill tightly with leveling compound.
- J. In areas listed on the Finish Schedule, remove existing floor closers, doorstops and thresholds and fill the voids to provide a surface for the new finish or thresholds.

3.3.7 Existing Base:

Where new base is scheduled or noted, remove existing base, cove, adhesive, etc. as required to provide a smooth, true surface to receive the new base.

3.3.8 Blocking:

Provide solid 2x6 wood blocking behind all door bumpers, millwork, toilet accessories, etc. at drywall partitions.

3.3.9 Existing Walls:

At existing walls that are to remain where intersecting walls are indicated to be removed, ensure that the structural stability of the remaining wall is retained. Carefully cut or break away the removed wall such that the new finish can be applied to the remaining wall with no noticeable traces of the removed wall.

Where plaster occurs, break back the plaster and fill the void to provide a true plane. Finish to match existing.

In all areas listed on the Finish Schedule at existing plastered walls, beams, columns, ceilings, soffits, door and window jambs and heads, etc., that are to remain and be visually exposed, the existing plaster shall be removed, and new plaster installed. The intent is that these walls shall have a newly plastered finish and no existing plaster finish will be exposed (the exception to this will be the plaster molding in U301 and U309 which will be sanded and repainted with any deteriorated or broken parts to be patched). All deteriorated or otherwise unsound plaster shall be removed to the structure, and all finish coat of plaster shall be removed. Any sound and properly bonded base and scratch coats may remain. Any missing, rusted, bent or loose plaster grounds and lath shall be replaced. New finish, base and scratch coat plaster shall be installed to produce a finished plaster surface including plaster at present missing plaster, where ceilings are raised and where woodwork and grounds are

removed. Remove and reinstall existing wood window aprons, handrails, etc. as required to facilitate installation of new plaster. See Finish Schedule for finishes to be provided over plaster.

3.3.10 New Ceilings:

In some areas of the building, utility space above new ceilings is minimal and will require special consideration and coordination. Heights of new ceilings may require slight adjustment to accommodate existing conditions and new utilities; however, varied ceiling heights must be approved by the Architect prior to installation of the utilities. This does not relieve the Contractor of his responsibility for coordinating the various trades.

3.3.11 CMU Walls:

Unless otherwise noted, CMU walls will be 8 inches.

3.3.12 Existing Doors, Frames and Hardware:

At all existing hollow metal doors and frames that are to remain and are listed on the Door Schedule, fill all extraneous holes, dents, scrapes, etc. with two-part catalytic automotive body filler to produce a smooth, true surface. Repaint and adjust door and hardware to produce a workable condition. If hardware is irreparable, replace with type, function, finish and keying to match existing.

3.3.13 New Doors and Frames:

Where new doors are scheduled in existing frames, remove existing doors and install new doors properly sized and prepared for the frame and hardware. Install new hardware where scheduled.

Where new frames are scheduled in existing walls to remain, rework wall (with material to match existing) to the new head/jamb/sill and provide the finish to match the scheduled or noted finish to produce a finished condition.

In accordance with ADA requirements, maintain required clearances between the strike jamb of all new doors and any intersecting obstruction such as wall, fixture, cabinet, etc.

3.3.14 Painting Scope:

All new work plus all previously painted surfaces in existing rooms are listed on the finish schedule. Refer to Section 09 90 00 for material requirements.

3.3.15 Miscellaneous Items:

Miscellaneous shelves, cabinets, chalk and tack boards, strips, bolts, pencil sharpeners, nails, toilet accessories, etc. are not indicated but shall be removed in rooms which are listed on the Finish Schedule, as required to accomplish finish work. Any reference to a specific item of this type is not intended to limit the scope of that type work. Affected area shall be repaired with same finish as the new adjacent finish (see Finish Schedule and Notes).

3.3.16 Related Items:

Unless otherwise noted, removal of an item (door, wall, ceiling, duct, etc.) shall include all frames, furring members, flashing, foundations, hangers, anchors, controls, piping, wiring, etc. related to the item.

3.3.17 Roof Flashing:

Flashing of new mechanical and electrical penetrations

Flash all such penetrations of existing roof areas to remain using flashing and counterflashing as recommended by the manufacturer of the roofing being penetrated. Provide appropriate blocking and nailers to receive flashing material.

3.3.18 Plumbing and Electrical Work:

In any case wherein a plumbing line, or an electrical conduit or line is encountered, the Contractor shall examine the entire line and ascertain the impact of the new work upon it. If said line must be adjusted or rerouted and was not shown nor reasonably foreseeable in a prebid examination of the site, the Contract sum will be adjusted.

3.3.19 Exposed Utilities:

Except where specifically indicated to be exposed, all new ducts, pipes, conduit, etc. in finished rooms shall be concealed above ceilings, below floors, in walls or in chases. Where no chases are indicated, provide closure to match adjacent construction and finish. Temporary plumbing, mechanical, electrical and sprinkler work that will be removed may be exposed.

3.4 EARTHWORK

3.4.1 Grading:

Fill, shape and dress yard area around new work so that water drains away from building and toward inlets, curbs, etc. Make adjustments in indicated grades as required to facilitate drainage, to protect tree roots, to dress out with undisturbed areas, etc. Do not unnecessarily disturb the earth.

3.4.2 Trenching:

Take care to avoid cutting tree roots. Hand excavate in areas within branch spread of existing trees and protect all roots of 1½" or greater diameter. Trenches which extend below the depth of the building foundation within a 45-degree angle of soil repose shall be excavated and backfilled prior to construction of the footing.

3.4.3 Excavating:

In the event any excavation must be made below and immediately adjacent to existing work which is to remain, thoroughly crib and shore against the building. Assume total responsibility for, and repair of, any settling or damage to that portion of the existing structure, which is to remain. See structural drawings for underpinning requirements.

3.5 FIRE RATINGS AT WALLS:

Where designations for fire walls occur, extend wall up to and seal against structural deck above (seal between joists, beams, trusses, etc.). Where gypsum board fire ceiling occurs, walls may be sealed to same. Seal around all plumbing, mechanical, electrical, etc. penetrations. Seal all voids per specification Section 07 24 00 to make wall smoketight and to maintain fire barrier. See finish schedules and painting specs for firewall signs and finish to be applied. See ceiling plan for firewall locations. See also typical wall sections.

One Hour Fire Walls:

- a. Where one-hour firewalls are required at drywall partitions, provide metal studs and minimum one-layer 5/8 inch fire rated gypsum board each side.
- b. Where one-hour firewalls are required at masonry partitions, provide minimum 6 inches CMU.

-- End of Section --

SECTION 01 74 19

CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL
02/19, CHG 3: 11/21

PART 1 GENERAL

1.1 DEFINITIONS

1.1.1 Co-mingle

The practice of placing unrelated materials together in a single container, usually for benefits of convenience and speed.

1.1.2 Construction Waste

Waste generated by construction activities, such as scrap materials, damaged or spoiled materials, temporary and expendable construction materials, and other waste generated by the workforce during construction activities.

1.1.3 Demolition Debris/Waste

Waste generated from demolition activities, including minor incidental demolition waste materials generated as a result of Intentional dismantling of all or portions of a building, to include clearing of building contents that have been destroyed or damaged.

1.1.4 Disposal

Depositing waste in a solid waste disposal facility, usually a managed landfill or incinerator, regulated in the US under the Resource Conservation and Recovery Act (RCRA).

1.1.5 Diversion

The practice of diverting waste from disposal in a landfill or incinerator, by means of eliminating or minimizing waste, or reuse of materials.

1.1.6 Final Construction Waste Diversion Report

A written assertion by a material recovery facility operator identifying constituent materials diverted from disposal, usually including summary tabulations of materials, weight in short-ton.

1.1.7 Recycling

The series of activities, including collection, separation, and processing, by which products or other materials are diverted from the solid waste stream for use in the form of raw materials in the manufacture of new products sold or distributed in commerce, or the reuse of such materials as substitutes for goods made of virgin materials, other than fuel.

1.1.8 Reuse

The use of a product or materials again for the same purpose, in its

original form or with little enhancement or change.

1.1.9 Salvage

Usable, salable items derived from buildings undergoing demolition or deconstruction, parts from vehicles, machinery, other equipment, or other components.

1.1.10 Source Separation

The practice of administering and implementing a management strategy to identify and segregate unrelated waste at the first opportunity.

1.2 CONSTRUCTION WASTE (INCLUDES DEMOLITION DEBRIS/WASTE)

Furnish lifting equipment as necessary to remove equipment designated for removal, and provide all equipment to transport the removed items off base. All unused material or debris will be removed from Government-controlled property. Use of Government-contracted dumpsters is prohibited. Unused materials, debris and rubbish shall be disposed of off base in a permitted landfill. The Contractor shall comply with Alabama Department of Environmental Management (ADEM) Code, Division 13, Solid Waste Program, and Chapter 335-13-1, through 335-13-8; Adopted November 18, 1981; Amended July 26, 1996.

All refrigerants must remain the possession of the Air Force.

Refrigerants from any refrigeration systems removed must be turned over to the Refrigerant Manager, 42CES/CEOH, 400 Cannon Street, Maxwell AFB.

1.3 CONSTRUCTION WASTE MANAGEMENT

Implement a Construction Waste Management Program for the project. Take a pro-active, responsible role in the management of construction construction waste, recycling process, disposal of demolition debris/waste, and require all subcontractors, vendors, and suppliers to participate in the Construction Waste Management Program. Establish a process for clear tracking, and documentation of construction waste and demolition debris/waste.

1.3.1 Implementation of Construction Waste Management Program

Develop and document how the Construction Waste Management Program will be implemented in a Construction Waste Management Plan. Submit a Construction Waste Management Plan to the Contracting Officer for approval. Construction waste and demolition debris/waste materials include un-used construction materials not incorporated in the final work, as well as demolition debris/waste materials from demolition activities or deconstruction activities. In the management of waste, consider the availability of viable markets, the condition of materials, the ability to provide material in suitable condition and in a quantity acceptable to available markets, and time constraints imposed by internal project completion mandates.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" classification. Submittals not having a "G" classification are for information only. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Construction Waste Management Plan

SD-06 Test Reports

Quarterly Reports

SD-11 Closeout Submittals

Final Construction Waste Diversion Report

1.5 CONSTRUCTION WASTE MANAGEMENT PLAN

Submit Construction Waste Management Plan within 15 calendar days after contract award. Revise and resubmit Construction Waste Management Plan as necessary, in order for construction to begin. Execute demolition or deconstruction activities in accordance with Section 02 41 00 DECONSTRUCTION. Manage demolition debris/waste or deconstruction materials in accordance with the approved construction waste management plan.

An approved Construction Waste Management Plan will not relieve the Contractor of responsibility for compliance with applicable environmental regulations or meeting project cumulative waste diversion requirement. Ensure all subcontractors receive a copy of the approved Construction Waste Management Plan. The plan demonstrates how to meet the project waste diversion requirement. Also, include the following in the plan:

- a. Identify the names of individuals responsible for waste management and waste management tracking, along with roles and responsibilities on the project..
- b. Actions that will be taken to reduce solid waste generation, including coordination with subcontractors to ensure awareness and participation.
- d. Description of the specific approaches to be used in recycling/reuse of the various materials generated, including the areas on site and equipment to be used for processing, sorting, and temporary storage of materials.
- e. Name of landfill and incinerator to be used.
- f. Identification of local and regional re-use programs, including non-profit organizations such as schools, local housing agencies, and organization that accept used materials such as material exchange networks and resale stores. Include the name, location, phone number for each re-use facility identified, and provide a copy of the permit or license for each facility.
- g. List of specific materials, by type and quantity, that will be salvaged for resale, salvaged and reused on the current project, salvaged and stored for reuse on a future project, or recycled. Identify the recycling facilities by name, address, and phone number.
- h. Identification of materials that cannot be recycled or reused with an explanation or justification, to be approved by the Contracting Officer.
- i. Description of the means by which materials identified in item (g)

above will be protected from contamination.

- j. Description of the means of transportation of the recyclable materials (whether materials will be site-separated and self-hauled to designated centers, or whether mixed materials will be collected by a waste hauler and removed from the site).
- k. Copy of training plan for subcontractors and other services to prevent contamination by co-mingling materials identified for diversion and waste materials.
- p. Identify local jurisdiction requirements for waste management. Include local requirements and points of contact.

Distribute copies of the waste management plan to each subcontractor, [Quality Control Manager](#) , and the Contracting Officer.

1.6 RECORDS (DOCUMENTATION)

1.6.1 General

Maintain records to document the types and quantities of waste generated and diverted through re-use, recycling and sale to third parties; through disposal to a landfill or incinerator facility. Provide explanations for materials not recycled, reused or sold. Collect and retain manifests, weight tickets, sales receipts, and invoices specifically identifying diverted project waste materials or disposed materials.

1.6.2 Accumulated

Maintain a running record of materials generated and diverted from landfill disposal, including accumulated diversion rates for the project. Make records available to the Contracting Officer during construction or incidental demolition activities. Provide a copy of the diversion records to the Contracting Officer upon completion of the construction, incidental demolitions or minor deconstruction activities.

1.7 REPORTS

1.7.1 General

Maintain current construction waste diversion information on site for periodic inspection by the Contracting Officer. Include in the quarterly reports, annual reports and final reports: the project name, contract information, information for waste generated, diverted and disposed of for the current reporting period and show cumulative totals for the project. Reports must identify quantities of waste by type and disposal method. Also include in each report, supporting documentation to include manifests, weigh tickets, receipts, and invoices specifically identifying the project and waste material type and weighted sum.

1.7.2 Quarterly Reporting

Provide cumulative reports at the end of each quarter (December, March, June, and September, corresponding with the federal fiscal year for reporting purposes). Submit [quarterly reports](#) not later than 15 calendar days after the preceding quarter has ended.

1.8 FINAL CONSTRUCTION WASTE DIVERSION REPORT

A Final Construction Waste Diversion Report is required at the end of the project. Provide [Final Construction Waste Diversion Report](#) 60 days prior to the Beneficial Occupancy Date (BOD).

1.9 COLLECTION

Collect, store, protect, and handle reusable and recyclable materials at the site in a manner which prevents contamination, and provides protection from the elements to preserve their usefulness and monetary value. Provide receptacles and storage areas designated specifically for recyclable and reusable materials and label them clearly and appropriately to prevent contamination from other waste materials. Keep receptacles or storage areas neat and clean.

Train subcontractors and other service providers to either separate waste streams or use the co-mingling method as described in the Construction Waste Management Plan. Handle hazardous waste and hazardous materials in accordance with applicable regulations and coordinate with Section 01 35 33 ENVIRONMENTAL PROCEDURES 02 81 00 TRANSPORTATION AND DISPOSAL OF HAZARDOUS MATERIALS. Separate materials by one of the following methods described herein:

1.9.1 Source Separation Method

Separate waste products and materials that are recyclable from trash and sort as described below into appropriately marked separate containers and then transport to the respective recycling facility for further processing. Deliver materials in accordance with recycling or reuse facility requirements (e.g., free of dirt, adhesives, solvents, petroleum contamination, and other substances deleterious to the recycling process). Separate materials into the category types as defined in the Construction Waste Management Plan.

1.9.2 Co-Mingled Method

Place waste products and recyclable materials into a single container and then transport to an authorized recycling facility, which meets all applicable requirements to accept and dispose of recyclable materials in accordance with all applicable local, state and federal regulations. The Co-mingled materials must be sorted and processed in accordance with the approved Construction Waste Management Plan.

1.9.3 Other Methods

Other methods proposed by the Contractor may be used when approved by the Contracting Officer.

1.10 DISPOSAL

Control accumulation of waste materials and trash. Recycle or dispose of collected materials off-site at intervals approved by the Contracting Officer and in compliance with waste management procedures as described in the waste management plan. Except as otherwise specified in other sections of the specifications, dispose of in accordance with the following:

1.10.1 Recycle

Recycle non-hazardous construction and demolition/debris materials that are not suitable for reuse. Track rejection of contaminated recyclable materials by the recycling facility. Rejected recyclables materials will not be counted as a percentage of diversion calculation. Recycle all fluorescent lamps, HID lamps, mercury (Hg) -containing thermostats and ampoules, and PCBs-containing ballasts and electrical components as directed by the Contracting Officer. Do not crush lamps on site as this creates a hazardous waste stream with additional handling requirements.

1.10.2 Waste

Dispose by landfill or incineration only those waste materials with no practical use, economic benefit, or recycling opportunity.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

Not used. -- End of Section --

SECTION 01 78 23

OPERATION AND MAINTENANCE DATA
08/15, CHG 2: 08/21

PART 1 GENERAL

1.1 SUBMITTALS

Government approval is required for submittals. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-10 Operation and Maintenance Data

Training Plan

Training Outline

Training Content

SD-11 Closeout Submittals

Training Video Recording

Validation of Training Completion

1.2 EQUIPMENT OPERATING, MAINTENANCE, AND REPAIR MANUALS:

Provide three (3) copies of each manual for approval to the Contracting Officer. The submittal schedule shall be as shown on the submittal register. Each manual format shall include the following:

- A. The manuals shall be bound in a 3-ring binder with a hard cover, or 3-hole portfolio for small projects. The following identification shall be inscribed on the cover: "EQUIPMENT OPERATING, MAINTENANCE, AND REPAIR MANUAL" and the building name and number, location, and indication of utility or system covered. Manuals shall be approximately 8 1/2 by 11 inches with large sheets folded in and capable of being easily pulled out for reference.
- B. Provide a warning page to warn of potential dangers (if they exist), such as high voltage, toxic chemicals, flammable liquids, explosive materials, carcinogens, or high pressures. The warning page shall be placed inside the front cover, in front of the title page.
- C. The title page shall show the name, address and phone number of the Contractor, the contract number and the date of publication.
- D. Provide a table of contents in accordance with standard commercial practice.

16.01 OTHER EQUIPMENT

The Contractor will be required to furnish a brochure, catalog cut sheet, parts list, manufacturer's spec sheet, and/or other printed information that shows detailed parts data, and the manufacturer's name, address, and telephone number, for all other equipment (such as hardware, lighting fixtures, etc.) subject to repair or maintenance procedures. The data shall

be furnished in three (3) copies (for each building) to the C.O. at the final inspection. This requirement is in addition to the requirements for material submittals specified elsewhere in this contract. Information submitted as a part of "Equipment Operating, Maintenance, and Repair Manuals" will be considered a part of this requirement.

1.3 OPERATION AND MAINTENANCE DATA

Submit Operation and Maintenance (O&M) Data for the provided equipment, product, or system, defining the importance of system interactions, troubleshooting, and long-term preventive operation and maintenance. Compile, prepare, and aggregate O&M data to include clarifying and updating the original sequences of operation to as-built conditions. Organize and present information in sufficient detail to clearly explain O&M requirements at the system, equipment, component, and subassembly level. Include an index preceding each submittal. Submit in accordance with this section and Section 01 33 00 SUBMITTAL PROCEDURES.

1.3.1 Package Quality

Documents must be fully legible. Operation and Maintenance data must be consistent with the manufacturer's standard brochures, schematics, printed instructions, general operating procedures, and safety precautions.

1.3.2 Changes to Submittals

Provide manufacturer-originated changes or revisions to submitted data if a component of an item is so affected subsequent to acceptance of the O&M Data. Submit changes, additions, or revisions required by the Contracting Officer for final acceptance of submitted data within 30 calendar days of the notification of this change requirement.

1.4 TYPES OF INFORMATION REQUIRED IN O&M DATA PACKAGES

Manuals shall include, in separate sections, the following information for each item of equipment and system:

- A. Performance sheets and graphs showing capacity data, efficiencies, electrical characteristics, pressure drops, and flow rates. Marked-up catalogs or catalog pages do not satisfy this requirement. Performance information shall be presented as concisely as possible and contain only data pertaining to equipment actually installed.
- B. Catalog cuts showing application information
- C. Installation information showing minimum acceptable requirements.
- D. Operation and maintenance requirements. Include adequate illustrative material to identify and locate operating controls, indicating devices and locations of areas or items requiring maintenance. Describe, in detail, starting and stopping procedures for components, adjustments required to obtain optimum equipment performance, and corrective actions for malfunctions. Maintenance instructions describing the nature and frequency of routine maintenance and procedures to be followed. Indicate any special tools, materials, and test equipment that may be required.
- E. Repair information including diagrams and schematics, guidance for diagnosing problems, and detailed instructions for making repairs.

Provide trouble-shooting information that includes a statement of the indication or symptom of trouble and the sequential instructions necessary. Include test hookups to determine the cause, special tools, and test equipment, and methods for returning the equipment to operating conditions. Information may be in chart form or in tabular format with appropriate headings.

- F. Parts list, names and addresses of the two closest parts supply agencies.
- G. Names and addresses of the local manufacturer representatives and the parent company.

1.4.1 Additional Requirements for HVAC Control Systems

Provide the following for control systems:

- a. Narrative description on how to perform and apply functions, features, modes, and other operations, including unoccupied operation, seasonal changeover, manual operation, and alarms. Include detailed technical manual for programming and customizing control loops and algorithms.
- b. Full as-built sequence of operations.
- c. Copies of checkout tests and calibrations performed by the Contractor (not Cx tests).
- d. Full points list. Provide a listing of rooms with the following information for each room:
 - (1) Floor
 - (2) Room number
 - (3) Room name
 - (4) Air handler unit ID
 - (5) Reference drawing number
 - (6) Air terminal unit tag ID
 - (7) Heating or cooling valve tag ID
 - (8) Minimum cfm
 - (9) Maximum cfm
- e. Full print out of all schedules and set points after testing and acceptance of the system.
- f. Full as-built print out of software program.
- g. Marking of system sensors and thermostats on the as-built floor plan and mechanical drawings with their control system designations.

1.4.2 Preventive Maintenance

Provide the following information for preventive and scheduled maintenance

to minimize repairs for the installed model and features of each system. Include potential environmental and indoor air quality impacts of recommended maintenance procedures and materials.

1.4.2.1 Lubrication Data

Include the following preventive maintenance lubrication data, in addition to instructions for lubrication required under paragraph OPERATOR SERVICE REQUIREMENTS:

- a. A table showing recommended lubricants for specific temperature ranges and applications.
- b. Charts with a schematic diagram of the equipment showing lubrication points, recommended types and grades of lubricants, and capacities.
- c. A Lubrication Schedule showing service interval frequency.

1.4.2.2 Preventive Maintenance Plan, Schedule, and Procedures

Provide manufacturer's schedule for routine preventive maintenance, inspections, condition monitoring (predictive tests) and adjustments required to ensure proper and economical operation and to minimize repairs. Provide instructions stating when the systems should be retested. Provide manufacturer's projection of preventive maintenance work-hours on a daily, weekly, monthly, and annual basis including craft requirements by type of craft. For periodic calibrations, provide manufacturer's specified frequency and procedures for each separate operation.

- a. Define the anticipated time required to perform each of each test (work-hours), test apparatus, number of personnel identified by responsibility, and a testing validation procedure permitting the record operation capability requirements within the schedule. Provide a remarks column for the testing validation procedure referencing operating limits of time, pressure, temperature, volume, voltage, current, acceleration, velocity, alignment, calibration, adjustments, cleaning, or special system notes. Delineate procedures for preventive maintenance, inspection, adjustment, lubrication and cleaning necessary to minimize repairs.
- b. Repair requirements must inform operators how to check out, troubleshoot, repair, and replace components of the system. Include electrical and mechanical schematics and diagrams and diagnostic techniques necessary to enable operation and troubleshooting of the system after acceptance.

1.4.3 Repair

Provide manufacturer's recommended procedures and instructions for correcting problems and making repairs.

1.4.3.1 Troubleshooting Guides and Diagnostic Techniques

Provide step-by-step procedures to promptly isolate the cause of typical malfunctions. Describe clearly why the checkout is performed and what conditions are to be sought. Identify tests or inspections and test equipment required to determine whether parts and equipment may be reused or require replacement.

1.4.3.2 Wiring Diagrams and Control Diagrams

Provide point-to-point drawings of wiring and control circuits including factory-field interfaces. Provide a complete and accurate depiction of the actual job specific wiring and control work. On diagrams, number electrical and electronic wiring and pneumatic control tubing and the terminals for each type, identically to actual installation configuration and numbering.

1.4.3.3 Repair Procedures

Provide instructions and a list of tools required to repair or restore the product or equipment to proper condition or operating standards.

1.4.3.4 Removal and Replacement Instructions

Provide step-by-step procedures and a list of required tools and supplies for removal, replacement, disassembly, and assembly of components, assemblies, subassemblies, accessories, and attachments. Provide tolerances, dimensions, settings and adjustments required. Use a combination of text and illustrations.

1.4.3.5 Spare Parts and Supply Lists

Provide lists of spare parts and supplies required for repair to ensure continued service or operation without unreasonable delays. List spare parts and supplies that have a long lead-time to obtain.

1.4.3.6 Repair Work-Hours

Provide manufacturer's projection of repair work-hours including requirements by type of craft. Identify, and tabulate separately, repair that requires the equipment manufacturer to complete or to participate.

1.4.4 Real Property Equipment

Provide a list of installed equipment furnished under this contract. Include all information usually listed on manufacturer's name plate. In the "EQUIPMENT-IN-PLACE LIST" include, as applicable, the following for each piece of equipment installed: description of item, location (by room number), model number, serial number, capacity, name and address of manufacturer, name and address of equipment supplier, condition, spare parts list, manufacturer's catalog, and warranty. Submit the final list 30 days after transfer of the completed facility.

Key the designations to the related area depicted on the contract drawings. List the following data:

RECORD OF DESIGNATED EQUIPMENT AND MATERIALS DATA				
Description	Specification Section	Manufacturer and Catalog, Model, and Serial Number	Composition and Size	Where Used

RECORD OF DESIGNATED EQUIPMENT AND MATERIALS DATA				

1.4.5 Appendices

Provide information required below and information not specified in the preceding paragraphs but pertinent to the maintenance or operation of the product or equipment. Include the following:

1.4.5.1 Product Submittal Data

Provide a copy of SD-03 Product Data submittals documented with the required approval.

1.4.5.2 Certificates

Provide a copy of SD-07 Certificates submittals documented with the required approval.

1.4.5.3 Manufacturer's Instructions

Provide a copy of SD-08 Manufacturer's Instructions submittals documented with the required approval.

1.4.5.4 O&M Submittal Data

Provide a copy of SD-10 Operation and Maintenance Data submittals documented with the required approval.

1.4.5.5 Parts Identification

Provide identification and coverage for the parts of each component, assembly, subassembly, and accessory of the end items subject to replacement. Include special hardware requirements, such as requirement to use high-strength bolts and nuts. Identify parts by make, model, serial number, and source of supply to allow reordering without further identification. Provide clear and legible illustrations, drawings, and exploded views to enable easy identification of the items. When illustrations omit the part numbers and description, both the illustrations and separate listing must show the index, reference, or key number that will cross-reference the illustrated part to the listed part. Group the parts shown in the listings by components, assemblies, and subassemblies in accordance with the manufacturer's standard practice. Parts data may cover more than one model or series of equipment, components, assemblies, subassemblies, attachments, or accessories, such as typically shown in a master parts catalog.

1.4.5.6 Warranty Information

List and explain the various warranties and clearly identify the servicing and technical precautions prescribed by the manufacturers or contract documents in order to keep warranties in force. Include warranty information for primary components of the system. Provide copies of warranties

1.4.5.7 Extended Warranty Information

List all warranties for products, equipment, components, and sub-components whose duration exceeds one year. For each warranty listed, indicate the applicable specification section, duration, start date, end date, and the point of contact for warranty fulfillment. Also, list or reference the specific operation and maintenance procedures that must be performed to keep the warranty valid. Provide copies of warranties required by Section 01 78 00 CLOSEOUT SUBMITTALS.

1.4.5.8 Personnel Training Requirements

Provide information available from the manufacturers that is needed for use in training designated personnel to properly operate and maintain the equipment and systems.

1.4.5.9 Testing Equipment and Special Tool Information

Include information on test equipment required to perform specified tests and on special tools needed for the operation, maintenance, and repair of components. Provide final set points.

1.4.5.10 Testing and Performance Data

Include completed prefunctional checklists, functional performance test forms, and monitoring reports. Include recommended schedule for retesting and blank test forms. Provide final set points.

1.4.5.11 Field Test Reports and Manufacturer's Field Reports

Provide a copy of Field Test Reports (SD-06) and Manufacturer's Field Reports (SD-09) submittals documented with the required approval.

1.4.5.12 Contractor Information

Provide a list that includes the name, address, and telephone number of the General Contractor and each Subcontractor who installed the product or equipment, or system. For each item, also provide the name address and telephone number of the manufacturer's representative and service organization that can provide replacements most convenient to the project site. Provide the name, address, and telephone number of the product, equipment, and system manufacturers.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.1 TRAINING

Prior to acceptance of the facility by the Contracting Officer for Beneficial Occupancy, provide comprehensive training for the systems and equipment specified in the technical specifications. The training must be targeted for the building maintenance personnel, and applicable building occupants. Instructors must be well-versed in the particular systems that they are presenting. Address aspects of the [Operation and Maintenance Manual submitted in accordance with Section 01 78 00 CLOSEOUT SUBMITTALS.]. Training must include classroom or field lectures based on the system

operating requirements. The location of classroom training requires approval by the Contracting Officer.

3.1.1 Training Plan

Submit a written training plan to the Contracting Officer for approval at least 60 calendar days prior to the scheduled training. Training plan must be approved by the [Quality Control Manager (QC)] prior to forwarding to the Contracting Officer. Also, coordinate the training schedule with the Contracting Officer and [QC]. Include within the plan the following elements:

- a. Equipment included in training
- b. Intended audience
- c. Location of training
- d. Dates of training
- e. Objectives
- f. Outline of the information to be presented and subjects covered including description
- g. Start and finish times and duration of training on each subject
- h. Methods (e.g. classroom lecture, video, site walk-through, actual operational demonstrations, written handouts)
- i. Instructor names and instructor qualifications for each subject
- j. List of texts and other materials to be furnished by the Contractor that are required to support training
- k. Description of proposed software to be used for video recording of training sessions.

3.1.2 Training Content

The core of this training must be based on manufacturer's recommendations and the operation and maintenance information. The [QC] is responsible for overseeing and approving the content and adequacy of the training. Spend 95 percent of the instruction time during the presentation on the OPERATION AND MAINTENANCE DATA. Include the following for each system training presentation:

- a. Start-up, normal operation, shutdown, unoccupied operation, seasonal changeover, manual operation, controls set-up and programming, troubleshooting, and alarms.
- b. Relevant health and safety issues.
- c. Discussion of how the feature or system is environmentally responsive. Advise adjustments and optimizing methods for energy conservation.
- d. Design intent.

- e. Use of O&M Manual Files.
- f. Review of control drawings and schematics.
- g. Interactions with other systems.
- h. Special maintenance and replacement sources.
- i. Tenant interaction issues.

3.1.3 Training Outline

Provide the [Operation and Maintenance Manual Files (Bookmarked PDF)]and a written course outline listing the major and minor topics to be discussed by the instructor on each day of the course to each trainee in the course. Provide the course outline 14 calendar days prior to the training.

3.1.4 Training Video Recording

Record classroom training session(s) on video. Provide to the Contracting Officer two copies of the training session(s) in DVD video recording format. Capture within the recording, in video and audio, the instructors' training presentations including question and answer periods with the attendees. The recording camera(s) must be attended by a person during the recording sessions to assure proper size of exhibits and projections during the recording are visible and readable when viewed as training.

3.1.5 Unresolved Questions from Attendees

If, at the end of the training course, there are questions from attendees that remain unresolved, the instructor must send the answers, in writing, to the Contracting Officer for transmittal to the attendees, and the training video must be modified to include the appropriate clarifications.

3.1.6 Validation of Training Completion

Ensure that each attendee at each training session signs a class roster daily to confirm Government participation in the training. At the completion of training, submit a signed validation letter that includes a sample record of training for reporting what systems were included in the training, who provided the training, when and where the training was performed, and copies of the signed class rosters. Provide two copies of the validation to the Contracting Officer, and one copy to the Operation and Maintenance Manual Preparer for inclusion into the Manual's documentation.

-- End of Section --

SECTION 02 41 00

SELECTIVE REMOVAL AND DEMOLITION

08/22

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF SAFETY PROFESSIONALS (ASSP)

ASSP A10.6

(2006) Safety & Health Program
Requirements for Demolition Operations -
American National Standard for
Construction and Demolition Operations

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1

(2014) Safety -- Safety and Health
Requirements Manual

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

40 CFR 61

National Emission Standards for Hazardous
Air Pollutants

1.2 PROJECT DESCRIPTION

1.2.1 SCOPE

That indicated or required to facilitate construction, generally including but not limited to the following:

- a. Partitions, doors, frames, windows, structure, equipment, casework, etc. noted on demolition drawings
- b. Floors, ceilings, concrete topping, etc. reflected on finish schedule and/or required to accomplish work Cutting of openings in walls, floors and decks.

1.2.2 Related Work

Section 07 32 19 - Metal Roof Tiles: Removal of roofing and materials associated with reroofing

Div 22, 23 and 26: Electrical, mechanical and plumbing work

Section 31 00 00 - Earthwork: Site clearing and removals

1.2.3 General Requirements

Do not begin selective demolition until authorization is received from the Contracting Officer. Remove rubbish and debris from the station daily ; do not allow accumulations inside or outside the buildings. The work

includes selective demolition, salvage of identified items and materials, and removal of resulting rubbish and debris. Remove rubbish and debris from Government property daily, unless otherwise directed. Store materials that cannot be removed daily in areas specified by the Contracting Officer. In the interest of occupational safety and health, perform the work in accordance with EM 385-1-1, Section 23, Demolition, and other applicable Sections.

1.2.3.1 Precautions:

Assume responsibility for any damage or loss from fire, theft, storm, settlement, collapse of any portion of this or adjacent structures as a result of work. Provide adequate shoring where required. Cease operations and take emergency precautions if at any time this or adjacent property appears to be endangered. Maintain free safe passage to and from existing building at all times. Do not permit debris to accumulate on site.

Protect all exposed wood frame portions of structure to remain with roofing felt or plastic. Strip heavy felt onto remaining roof plies and secure over edge to protect joist space. Immediately close doors and other opening created to make weatherproof and as required to protect the property. Remove finish materials so as to avoid damage to substrate to remain.

1.3 ITEMS TO REMAIN IN PLACE

Comply with FAR 52.236-9 to protect existing vegetation, structures, equipment, utilities, and improvements. Coordinate the work of this section with all other work indicated. Construct and maintain shoring, bracing, and supports as required. Ensure that structural elements are not overloaded. Increase structural supports or add new supports as may be required as a result of any cutting, removal, deconstruction, or demolition work performed under this contract. Do not overload structural elements. Provide new supports and reinforcement for existing construction weakened by demolition, deconstruction, or removal work. Repairs, reinforcement, or structural replacement require approval by the Contracting Officer prior to performing such work.

1.3.1 Existing Construction Limits and Protection

Do not disturb existing construction beyond the extent indicated or necessary for installation of new construction. Provide temporary shoring and bracing for support of building components to prevent settlement or other movement. Provide protective measures to control accumulation and migration of dust and dirt in all work areas. Remove dust, dirt, and debris from work areas daily.

1.3.2 Weather Protection

For portions of the building to remain, protect building interior and materials and equipment from the weather at all times. Where removal of existing roofing is necessary to accomplish work, have materials and workmen ready to provide adequate and temporary covering of exposed areas.

1.3.3 Trees

Protect trees indicated to remain within the project site which might be damaged during demolition or deconstruction, by a 6 foot high fence.

Erect and secure fence a minimum of 5 feet from the trunk of individual trees or follow the outer perimeter of branches or clumps of trees. Replace any tree designated to remain that is damaged during the work under this contract with like-kind or as approved by the Contracting Officer.

1.3.4 Utility Service

Maintain existing utilities indicated to stay in service and protect against damage during demolition and deconstruction operations. Prior to start of work, utilities serving each area of alteration or removal will be shut off by the Government and disconnected and sealed by the Contractor.

1.3.5 Facilities

Protect electrical and mechanical services and utilities. Where removal of existing utilities and pavement is specified or indicated, provide approved barricades, temporary covering of exposed areas, and temporary services or connections for electrical and mechanical utilities. Floors, roofs, walls, columns, pilasters, and other structural components that are designed and constructed to stand without lateral support or shoring, and are determined to be in stable condition, must remain standing without additional bracing, shoring, or lateral support until demolished or deconstructed, unless directed otherwise by the Contracting Officer. Ensure that no elements determined to be unstable are left unsupported and place and secure bracing, shoring, or lateral supports as may be required as a result of any cutting, removal, deconstruction, or demolition work performed under this contract.

1.4 BURNING

The use of burning at the project site for the disposal of refuse and debris will not be permitted

1.5 SUBMITTALS

Government approval is required for submittals. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Existing Conditions

SD-07 Certificates

Notification

1.6 QUALITY ASSURANCE

Submit timely notification of demolition and renovation projects to Federal, State, regional, and local authorities in accordance with 40 CFR 61, Subpart M. Notify the Regional Office of the United States Environmental Protection Agency (USEPA) and the Contracting Officer in writing 10 working days prior to the commencement of work in accordance with 40 CFR 61, Subpart M. Comply with federal, state, and local hauling and disposal regulations. In addition to the requirements of the "Contract Clauses," conform to the safety requirements contained in ASSP A10.6. Comply with the Environmental Protection Agency requirements

specified. Use of explosives will not be permitted.

1.7 PROTECTION

1.7.1 Traffic Control Signs

a. Where pedestrian and driver safety is endangered in the area of removal work, use traffic barricades with flashing lights. Anchor barricades in a manner to prevent displacement by wind. Notify the Contracting Officer prior to beginning such work.

1.7.2 Protection of Personnel

Before, during and after the renovation work continuously evaluate the condition of the structure being renovated and take immediate action to protect all personnel working in and around the project site. No area, section, or component of floors, roofs, walls, columns, pilasters, or other structural element will be allowed to be left standing without sufficient bracing, shoring, or lateral support to prevent collapse or failure while workmen remove debris or perform other work in the immediate area.

1.7.3 Asbestos

During the commission of the work of this section, if the personnel or contractor encounters what they think may be asbestos, they are required to stop and contact the MAFB Asbestos Point of Contact at the Maxwell Environmental Section (Base Environmental office 42 CES/CEIE); 334-953-5260 during duty hours and 334-953-3333 during off hours.

Upon determination that asbestos is present, refer to the requirements of Section 02 82 00 - Asbestos Remediation

1.8 RELOCATIONS

Perform the removal and reinstallation of relocated items as indicated with workmen skilled in the trades involved. Repair or replace items to be relocated which are damaged by the Contractor with new undamaged items as approved by the Contracting Officer.

1.9 EXISTING CONDITIONS

Before beginning any renovation work, survey the site and examine the drawings and specifications to determine the extent of the work. Record existing conditions in the presence of the Contracting Officer showing the condition of structures and other facilities adjacent to areas of alteration or removal. Photographs or electronic images with a minimum resolution of 3072 x 2304 pixels, capable of a print resolution of 300 dpi, will be acceptable as a record of existing conditions. Include in the record the elevation of the top of foundation walls, finish floor elevations, possible conflicting electrical conduits, plumbing lines, alarms systems, the location and extent of existing cracks and other damage and description of surface conditions that exist prior to starting work. It is the Contractor's responsibility to verify and document all required outages which will be required during the course of work, and to note these outages on the record document. Submit survey results to the Contracting Officer.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION

3.1 EXISTING FACILITIES TO BE REMOVED

Inspect and evaluate existing structures onsite for reuse. Disassemble existing construction scheduled to be removed for reuse. Dismantled and removed materials are to be separated, set aside, and prepared as specified, and stored or delivered to a collection point for reuse, remanufacture, recycling, or other disposal, as specified. Designate materials for reuse onsite whenever possible.

3.1.1 Structures

Demolition Procedures: Remove all material in small sections. Carefully lower beams and other heavy members to the ground. Demolish walls, piers, etc. to 3 feet below ground level. Remove any wood construction completely. Remove concrete slabs except that slabs over 3 feet below finish grade may be broken up and left in place. Keep work wet down to prevent dust from rising.

Cutting: Take care to cut openings as square and neat as practical. Saw cut concrete work which will be exposed; scribe cut in any event.

3.1.2 Utilities and Related Equipment

3.1.2.1 General Requirements

Do not interrupt existing utilities serving occupied or used facilities, except when authorized in writing by the Contracting Officer. Do not interrupt existing utilities serving facilities occupied and used by the Government except when approved in writing and then only after temporary utility services have been approved and provided. Do not begin demolition or deconstruction work until all utility disconnections have been made. Shut off and cap utilities for future use, as indicated.

3.1.2.2 Disconnecting Existing Utilities

Remove existing utilities, as indicated and terminate in a manner conforming to the nationally recognized code covering the specific utility and approved by the Contracting Officer. When utility lines are encountered but are not indicated on the drawings, notify the Contracting Officer prior to further work in that area. Abandoned utilities which are deep enough not to interfere with new construction may remain in place; all open ends of such abandoned pipe shall be plugged solid with concrete. Before plugging, drain plumbing lines and properly disconnect power lines. If gasoline lines are encountered seek instructions. Remove meters and related equipment and deliver to a location on the station in accordance with instructions of the Contracting Officer.

3.1.3 Roofing

Remove existing roof system and associated components in their entirety down to existing roof deck. Remove roofing system and insulation without damaging the roof deck. Sequence work to minimize building exposure between demolition or deconstruction and new roof materials installation.

3.1.3.1 Temporary Roofing

Install temporary roofing and flashing as necessary to maintain a watertight condition throughout the course of the work. Remove temporary work prior to installation of permanent roof system materials unless approved otherwise by the Contracting Officer. Make provisions for worker safety during reroofing operations and installation of new materials as described in paragraphs entitled "Statements" and "Regulatory and Safety Requirements."

3.1.3.2 Reroofing

When removing the existing roofing system from the roof deck, remove only as much roofing as can be recovered by the end of the work day, unless approved otherwise by the Contracting Officer. Do not attempt to open the roof covering system in threatening weather. Reseal all openings prior to suspension of work the same day.

3.1.4 Masonry

Sawcut and remove masonry so as to prevent damage to surfaces to remain, and to facilitate the installation of new work. Where new masonry adjoins existing, abut or tie the new work into the existing construction as indicated. Provide square, straight edges and corners where existing masonry adjoins new work and other locations.

3.1.5 Concrete

Saw concrete along straight lines to a depth of a minimum 2 inch. Make each cut in walls perpendicular to the face and in alignment with the cut in the opposite face. Break out the remainder of the concrete provided that the broken area is concealed in the finished work, and the remaining concrete is sound. At locations where the broken face cannot be concealed, grind smooth or saw cut entirely through the concrete. Sawcuts in existing concrete must be at the nearest existing expansion joint or weakened plane joint and at full depth.

3.1.6 Structural Steel

Dismantle structural steel at field connections and in a manner that will prevent bending or damage. Salvage for recycle structural steel, steel joists, girders, angles, plates, columns and shapes. Do not use flame-cutting torches. Transport steel joists and girders as whole units and not dismantled. Transport structural steel shapes to a designated recycling facility area as directed by the Contracting Officer, stacked according to size, type of member and length, and stored off the ground, protected from the weather.

3.1.7 Miscellaneous Metal

Salvage shop-fabricated items such as access doors and frames, steel gratings, metal ladders, wire mesh partitions, metal railings, metal windows and similar items as whole units. Salvage light-gage and cold-formed metal framing, such as steel studs, steel trusses, metal gutters, roofing and siding, metal toilet partitions, toilet accessories and similar items. Scrap metal is the Contractor's property. Recycle scrap metal as part of demolition and deconstruction operations. Provide separate containers to collect scrap metal and transport to a scrap metal collection or recycling facility, in accordance with the Waste Management

Plan.

3.1.8 Carpentry

Remove windows, doors, frames, and cabinets, and similar items indicated to be removed as whole units, complete with trim and accessories.

3.1.9 Acoustic Ceiling Tile

Remove, neatly stack, and recycle acoustic ceiling tiles. Recycling may be available with manufacturer. Otherwise, give priority to a local recycling organization. Recycling is not required if the tiles contain or may have been exposed to asbestos material.

3.1.10 Patching

Where removals leave holes and damaged surfaces exposed in the finished work, patch and repair these holes and damaged surfaces to match adjacent finished surfaces, using on-site materials when available. Where new work is to be applied to existing surfaces, perform removals and patching in a manner to produce surfaces suitable for receiving new work. Make finished surfaces of patched area flush with the adjacent existing surface and match the existing adjacent surface as closely as possible to texture and finish. Provide patching as specified and indicated, and include the following:

- a. Concrete and Masonry: Completely fill holes and depressions, caused by previous physical damage or left as a result of removals in existing masonry walls to remain, with an approved masonry patching material, applied in accordance with the manufacturer's printed instructions.
- b. Where existing partitions have been removed leaving damaged or missing resilient tile flooring, patch to match the existing floor tile.
- c. Patch acoustic lay-in ceiling where partitions have been removed. Make the transition between the different ceiling heights by continuing the higher ceiling level over to the first runner on the lower ceiling and closing the vertical opening with a painted sheet metal strip.

3.1.11 Air Conditioning Equipment

Remove air conditioning, refrigeration, and other equipment containing refrigerants without releasing chlorofluorocarbon refrigerants to the atmosphere in accordance with the Clean Air Act Amendment of 1990. Recover all refrigerants prior to removing air conditioning, refrigeration, and other equipment containing refrigerants and dispose of in accordance with the paragraph entitled "Disposal of Ozone Depleting Substance (ODS)." All refrigerants must remain the possession of the Air Force. Refrigerants from any refrigeration systems removed must be turned over to the Refrigerant Manager, 42CES/CEOH, 400 Cannon Street, Maxwell AFB.

3.1.12 Cylinders and Canisters

Remove all fire suppression system cylinders and canisters and dispose of in accordance with the paragraph entitled "Disposal of Ozone Depleting Substance (ODS)."

3.1.13 Locksets on Swinging Doors

Remove all locksets from all swinging doors indicated to be removed and disposed of. Deliver the locksets and related items to a designated location for receipt by the Contracting Officer after removal.

3.1.14 Mechanical Equipment and Fixtures

Disconnect mechanical hardware at the nearest connection to existing services to remain, unless otherwise noted. Disconnect mechanical equipment and fixtures at fittings. Remove service valves attached to the unit. Salvage each item of equipment and fixtures as a whole unit; listed, indexed, tagged, and stored. Salvage each unit with its normal operating auxiliary equipment. Transport salvaged equipment and fixtures, including motors and machines, to a designated storage area as directed by the Contracting Officer. Do not remove equipment until approved. Do not offer low-efficiency equipment for reuse; provide to recycling service for disassembly and recycling of parts.

3.1.14.1 Preparation for Storage

Remove water, dirt, dust, and foreign matter from units; drain tanks, piping and fixtures; if previously used to store flammable, explosive, or other dangerous liquids, steam clean interiors. Seal openings with caps, plates, or plugs. Secure motors attached by flexible connections to the unit. Change lubricating systems with the proper oil or grease.

3.1.14.2 Piping

Disconnect piping at unions, flanges and valves, and fittings as required to reduce the pipe into straight lengths for practical storage. Store salvaged piping according to size and type. If the piping that remains can become pressurized due to upstream valve failure, attach end caps, blind flanges, or other types of plugs or fittings with a pressure gage and bleed valve to the open end of the pipe to ensure positive leak control. Carefully dismantle piping that previously contained gas, gasoline, oil, or other dangerous fluids, with precautions taken to prevent injury to persons and property. Store piping outdoors until all fumes and residues are removed. Box prefabricated supports, hangers, plates, valves, and specialty items according to size and type. Wrap sprinkler heads individually in plastic bags before boxing. Classify piping not designated for salvage, or not reusable, as scrap metal.

3.1.14.3 Ducts

Classify removed duct work as scrap metal.

3.1.14.4 Fixtures, Motors and Machines

Remove and salvage fixtures, motors and machines associated with plumbing, heating, air conditioning, refrigeration, and other mechanical system installations. Salvage, box and store auxiliary units and accessories with the main motor and machines. Tag salvaged items for identification, storage, and protection from damage. Classify non-porcelain broken, damaged, or otherwise unserviceable units and not caused to be broken, damaged, or otherwise unserviceable as debris to be disposed of by the Contractor. Salvage and crush porcelain plumbing fixtures unsuitable for reuse.

3.1.15 Electrical Equipment and Fixtures

Salvage motors, motor controllers, and operating and control equipment that are attached to the driven equipment. Salvage wiring systems and components. Box loose items and tag for identification. Disconnect primary, secondary, control, communication, and signal circuits at the point of attachment to their distribution system.

3.1.15.1 Fixtures

Remove and salvage electrical fixtures. Salvage unprotected glassware from the fixture and salvage separately. Salvage incandescent, mercury-vapor, and fluorescent lamps and fluorescent ballasts manufactured prior to 1978, boxed and tagged for identification, and protected from breakage.

3.1.15.2 Electrical Devices

Remove and salvage switches, switchgear, transformers, conductors including wire and nonmetallic sheathed and flexible armored cable, regulators, meters, instruments, plates, circuit breakers, panelboards, outlet boxes, and similar items. Box and tag these items for identification according to type and size.

3.1.15.3 Wiring Ducts or Troughs

Remove and salvage wiring ducts or troughs. Dismantle plug-in ducts and wiring troughs into unit lengths. Remove plug-in or disconnecting devices from the busway and store separately.

3.1.15.4 Conduit and Miscellaneous Items

Salvage conduit except where embedded in concrete or masonry. Consider corroded, bent, or damaged conduit as scrap metal. Sort straight and undamaged lengths of conduit according to size and type. Classify supports, knobs, tubes, cleats, and straps as debris to be removed and disposed.

3.2 CONCURRENT EARTH-MOVING OPERATIONS

Do not begin excavation, filling, and other earth-moving operations that are sequential to demolition or deconstruction work in areas occupied by structures to be demolished or deconstructed until all demolition and deconstruction in the area has been completed and debris removed. Fill holes, open basements and other hazardous openings.

3.3 DISPOSITION OF MATERIAL

3.3.1 Title to Materials

Except for salvaged items specified in related Sections, and for materials or equipment scheduled for salvage, all materials and equipment removed and not reused or salvaged, become the property of the Contractor and must be removed from Government property. Materials approved for storage by the Contracting Officer must be removed before completion of the contract. Title to materials resulting from demolition and deconstruction, and materials and equipment to be removed, is vested in the Contractor upon approval by the Contracting Officer. The Government will not be responsible for the condition or loss of, or damage to, such

property after contract award. Showing for sale or selling materials and equipment on site is prohibited.

3.4 CLEANUP

Remove debris and rubbish from project site and similar excavations. Remove and transport the debris in a manner that prevents spillage on streets or adjacent areas. Apply local regulations regarding hauling and disposal.

3.5 DISPOSAL OF REMOVED MATERIALS

3.5.1 Regulation of Removed Materials

Dispose of debris, rubbish, scrap, and other nonsalvageable materials resulting from removal operations with all applicable federal, state and local regulations. Storage of removed materials on the project site is prohibited.

3.5.2 Burning on Government Property

Burning of materials removed from renovation activities on structures will not be permitted on Government property.

3.5.3 Removal from Government Property

Transport waste materials removed from demolished and deconstructed structures, except waste soil, from Government property for legal disposal. Dispose of waste soil per Section 01 35 33 ENVIRONMENTAL PREOCEDURES.

-- End of Section --

SECTION 02 42 91

REMOVAL AND SALVAGE OF HISTORIC CONSTRUCTION MATERIALS 11/18

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.1000	Air Contaminants
29 CFR 1926.55	Gases, Vapors, Fumes, Dusts, and Mists
40 CFR 261	Identification and Listing of Hazardous Waste

1.2 PROJECT DESCRIPTION

The work includes removal and salvage of identified historic items and materials, and removal of resulting rubbish and debris. General demolition of non-historic materials and removal of resulting rubbish and debris must comply with the requirements of Section 02 41 00 - **Selective Removal and Demolition**. Store salvaged or recycled materials daily in areas and in a manner specified by the Contracting Officer. In the interest of conservation, pursue salvage and recycling to the maximum extent possible. Submit a **Work Plan** that includes procedures proposed for the accomplishment of the work. The Work Plan procedures must provide for safe conduct of the work, careful removal and disposition of materials specified to be salvaged or recycled, dust control, protection of property which is to remain undisturbed, coordination with other work in progress, and timely disconnection of utility services. Include a detailed description of the methods and equipment to be used for each operation, and the sequence of operations in the Work Plan.

1.2.1 Dust Control

Control the amount of dust resulting from removal, salvage and demolition operations to prevent the spread of dust to occupied portions of the construction site, to avoid creation of a nuisance in the surrounding area and to minimize occupational exposures. Occupational exposures cannot exceed the requirements in 29 CFR 1910.1000 and 29 CFR 1926.55. Use of water to control dust will not be permitted when it will result in, or create, damage to existing building materials and hazardous or objectionable conditions such as ice, flooding and pollution.

1.2.2 Protection

1.2.2.1 Protection of Existing Historic Property

Survey the site and examine the drawings and specifications to determine the extent of work before beginning any removal, salvage or demolition work. Take necessary precautions to avoid damage to existing historic

items that are to remain in place, to be reused, or to remain the property of the Government. Repair or restore items damaged by the Contractor to original condition, or replace, as approved by the Contracting Officer. Coordinate the work of this section with all other work and construct and maintain shoring, bracing and supports, as required. Ensure that structural elements are not overloaded and provide additional supports as may be required as a result of any cutting, removal, or demolition work performed under this contract.

1.2.2.2 Protection From the Weather

Protect the interior of buildings to remain and salvageable materials from the weather at all times. Store salvaged historic materials off the ground and under weathertight covering.

1.2.2.3 Environmental Protection

Comply with the requirements of Section 02 82 00 ASBESTOS REMEDIATION. Ensure a thorough inspection has been performed for hazardous materials prior to beginning work.

1.3 SUBMITTALS

Government approval is required for submittals. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Work Plan

1.4 QUALIFICATIONS

Provide qualified workers trained and experienced in whole-building recycling, including removal and salvage of historic materials. Submit documentation of five consecutive years of work of this type with a list of similar projects identifying when, where, and for whom the work was done. Provide a current point-of-contact for identified references.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

3.1 HAZARDOUS MATERIALS

Unforeseen hazardous materials may exist in wall cavities, beneath floors, in chases, inside various components, as well as other building materials. Exercise extreme care when performing demolition and salvage operations to ensure unexpected hazardous materials area not inadvertently disturbed creating a potential exposure concern. If suspect hazardous materials are observed or encountered, stop work and notify the Contracting Officer immediately.

3.2 SALVAGED ITEMS

Salvage items to the maximum extent possible. Remove historic items to be salvaged from the structure prior to demolition work. Remove salvageable items by hand labor to the maximum extent possible. Do not damage

historic portions of the structure to remain or items identified for salvage. Remove furnishings, equipment, and materials not scheduled for salvage or recycling prior to any salvaging procedures. Keep a complete recording of all salvaged materials including the condition of such materials before, and after, salvage operations.

3.2.1 Site Work

Remove intact and salvage the following site items: [fences and gates] [site furnishings] [fountains] [sculpture] [site ornaments] [site lighting fixtures] [_____].

3.2.2 Concrete

Remove intact and salvage the following concrete items: [precast architectural elements] [_____].

3.2.3 Masonry

Remove intact and salvage the following masonry items: [brick] [stone] [terra cotta] [cast stone] [clay tile trim elements] [cornerstones] [_____].

3.2.4 Metals

Remove intact and salvage the following metal items: [ladders] [stairs and handrails] [cast architectural ornament] [architectural metalwork] [ornamental ironwork] [gratings and metal walkways] [_____].

3.2.5 Wood

Remove intact and salvage the following materials: [wood decking] [millwork] [custom paneling] [wood stairs and handrails] [ladders] [architectural woodwork] [custom casework] [wood timbers (5 x 5 inch or larger)] [_____].

3.2.6 Thermal and Moisture Protection

Remove intact and salvage the following materials: [slate tiles] [clay tiles] [gutters, leaders, and downspouts] [skylights] [roof accessories] [exterior siding] [_____].

3.2.7 Doors and Windows

Remove doors and windows with associated hardware and operating mechanisms intact (including glass) and salvage in accordance with the schedule.

3.2.8 Finishes

[Remove][protect] the following special or historic finishes : [stenciling] [decorative tile] [molded ornament] [decorative ceiling materials] [wood flooring] [textured wall coverings] [murals] [_____].

3.2.9 Equipment and Specialty Items

Remove intact and salvage the following equipment and specialty items: [chalkboards and tackboards] [toilet partitions] [louvers and vents] [stoves] [plaques] [lockers] [mirrors] [bath accessories] [partitions] [contents of cornerstones] [document boxes] [_____].

3.2.10 Mechanical Equipment

Remove intact and salvage the following mechanical equipment: [bathroom fixtures] [radiators] [registers and grilles] [fans] [_____].

3.2.11 Electrical Equipment

Remove intact and salvage the following electrical fixtures and equipment: [light fixtures] [switches] [switch plates] [outlet covers] [clocks] [telecommunications equipment] [_____].

3.3 RECYCLED MATERIALS

Recycle materials to the maximum extent possible. Use hand labor wherever possible to remove recyclable materials. Do not damage historic portions of the structure indicated to remain and items identified for salvage while removing materials for recycling. Recycle the following materials: [dimension lumber] [scrap wood] [paper and cardboard] [gypsum wallboard] [asphalt] [rubble] [glass] [metals] [_____].

3.4 DISPOSITION OF MATERIALS

The Contractor, upon receipt of notice to proceed, is vested with the title to materials and equipment to be demolished, except Government and using service salvage and historical items. The Government will not be responsible for the condition, loss or damage to such property after notice to proceed.

3.4.1 Material Salvaged for the Contractor

Temporarily store salvaged material as approved by the Contracting Officer and remove from Government property before completion of the contract. Sale of salvaged material on the site is prohibited.

3.4.2 Items Salvaged for the Government

Remove salvaged items to remain the property of the Government in a manner to prevent damage, packed or crated to protect the items from damage, or as directed by the Contracting Officer. Repair or replace items damaged during removal or storage to match existing items. Properly label and identify containers as to contents. Deliver the following items reserved as property of the Government to the areas designated: [_____].

3.4.3 Items Salvaged for the Using Service

Prior to commencement of work under this contract, remove the following items reserved as property of the using service: [_____].

3.5 CLEAN-UP

Upon completion of the work, clean portions of structure to remain and adjacent areas and structures of dust, dirt, and debris caused by salvage and demolition operations. Verify that debris and rubbish created by the work is non-hazardous. If any debris and rubbish is suspect hazardous waste characterize it in accordance with 40 CFR 261. If the debris and rubbish is determined to be hazardous materials notify the Contracting

Officer. Remove and transport non-hazardous debris and rubbish in a manner that prevents spillage on streets or adjacent areas. Transport and dispose of all material in accordance with all local, state and Federal regulations. Provide copies of all disposal manifests to the the Contracting Officer.

-- End of Section --

SECTION 02 61 13

EXCAVATION AND HANDLING OF CONTAMINATED MATERIAL

02/10, CHG 1: 02/21

PART 1 GENERAL

1.1 MEASUREMENT AND PAYMENT

1.1.1 Measurement

Base measurement for excavation and onsite transportation on the actual number of cubic yards of contaminated material in-place prior to excavation. Base determination of the volume of contaminated material excavated on cross-sectional volume determination reflecting the differential between the original elevations of the top of the contaminated material and the final elevations after removal of the contaminated material. Base measurement for backfilling of excavated areas on in-place cubic yards of compacted fill. Base measurement for construction of stockpile areas on the number of square yards of stockpile liner constructed.

1.1.2 Payment

1.1.2.1 Excavation and Transportation

Compensation for excavation and onsite transportation of contaminated material will be paid as a unit cost. Include any other items incidental to excavation and handling not defined as having a specific unit cost.

1.1.2.2 Backfilling

Compensation for backfill soil, transportation of backfill, backfill soil conditioning, backfilling, compaction, and geotechnical testing will be paid as a single unit cost.

1.1.2.3 Stockpiling

Compensation for construction of stockpile areas will be paid for as a unit cost. Include all aspects of grading, preparation, handling, placement, maintenance, removal, treatment, and disposal of stockpile cover materials and liner materials and all other items incidental to construction of stockpiles in the unit cost.

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D698 (2012; E 2014; E 2015) Laboratory
Compaction Characteristics of Soil Using
Standard Effort (12,400 ft-lbf/cu. ft.
(600 kN-m/cu. m.))

ASTM D1556/D1556M (2015; E 2016) Standard Test Method for

Density and Unit Weight of Soil in Place
by Sand-Cone Method

ASTM D1557

(2012; E 2015) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³) (2700 kN-m/m³)

ASTM D2167

(2015) Density and Unit Weight of Soil in Place by the Rubber Balloon Method

ASTM D2487

(2017; E 2020) Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)

ASTM D5434

(2012) Field Logging of Subsurface Explorations of Soil and Rock

ASTM D6938

(2017a) Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

ASTM D7928

(2017) Standard Test Method for Particle-Size Distribution (Gradation) of Fine-Grained Soils Using the Sedimentation (Hydrometer) Analysis

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1

(2014) Safety -- Safety and Health Requirements Manual

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1926

Safety and Health Regulations for Construction

40 CFR 302

Designation, Reportable Quantities, and Notification

1.3 DESCRIPTION OF WORK

The work consists of excavation and temporary storage of approximately [____] cubic yards of contaminated material. Approximate locations of contaminated material are shown on the drawings. Characterization data on the nature and extent of the contaminated material is shown in Appendix [____]. Subsurface conditions are shown [on the drawings] [in Appendix [____]]. Submit a Work Plan as specified below. Notify the Contracting Officer within [24] [____] hours, and before excavation, if contaminated material is discovered that has not been previously identified or if other discrepancies between data provided and actual field conditions are discovered. Backfill material is [not available onsite] [available onsite and typically consists of [____]]. Ground water is approximately [____] feet below pre-excavation ground surface. Conduct required sampling and chemical analysis in accordance with [____].

1.3.1 Scheduling

Notify the Contracting Officer [_____] calendar days prior to the start of excavation of contaminated material. The [Contracting Officer] [Contractor] is responsible for contacting regulatory agencies in accordance with the applicable reporting requirements.

1.3.2 Work Plan

Submit a Work Plan within [30] [_____] calendar days after notice to proceed. Do not perform work at the site, with the except site inspections and surveys, until the Work Plan is approved. Allow [30] [_____] calendar days in the schedule for the Government's review. No adjustment for time or money will be made if resubmittals of the Work Plan are required due to deficiencies in the plan. At a minimum, include the following in the the Work Plan:

- a. Schedule of activities.
- b. Method of excavation and equipment to be used.
- c. Shoring or side-wall slopes proposed.
- d. Dewatering plan.
- e. Storage methods and locations for liquid and solid contaminated material.
- f. Borrow sources and haul routes.
- g. Decontamination procedures.
- h. Spill contingency plan.

1.3.3 Other Submittal Requirements

Submit separate cross-sections of each area before and after excavation and after backfilling, test results, and [_____] copies of the Closure Report within [14] [_____] calendar days of work completion at the site.

1.4 SUBMITTALS

Government approval is required for submittals. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Work Plan

SD-02 Shop Drawings

Surveys

SD-06 Test Reports

Compaction

Closure Report

1.5 REGULATORY REQUIREMENTS

1.5.1 Permits and Licenses

Obtain required federal, state, and local permits for excavation and storage of contaminated material. Obtain permits at no additional cost to the Government.

1.5.2 Air Emissions

Monitor and control air emissions in accordance with Section 01 35 33
ENVIRONMENTAL PROCEDURES

PART 2 PRODUCTS

2.1 SPILL RESPONSE MATERIALS

Provide appropriate spill response materials including, but not limited to the following: containers, adsorbents, shovels, and personal protective equipment. Make spill response materials available at all times when contaminated materials/wastes are being handled or transported. Provide spill response materials that are compatible with the type of materials and contaminants being handled.

2.2 BACKFILL

Obtain backfill material from [the location indicated on the drawings] [offsite sources approved by the Contracting Officer]. Classify backfill in accordance with ASTM D2487 as GW, GP, GM, GC, SW, SP, SM, SC, ML, MH, CL, or CH. Provide backfill that is free from roots and other organic matter, trash, debris, snow, ice or frozen materials. Test backfill material for the parameters listed below at a frequency of once per [3000] [_____] cubic yards. Perform a minimum of one set of classification tests per borrow source. Also collect and test [one] [_____] backfill sample per borrow source for the chemical parameters listed below.

Physical Parameter	Criteria	Test Method
Grain Size	[_____]	ASTM D7928
Compaction	[_____]	ASTM D698
[_____]	[_____]	[_____]

Chemical Parameter	Test Frequency	Criteria
[_____]	[_____]	[_____]

Do not use material for backfill until borrow source chemical and physical test results have been submitted and approved.

PART 3 EXECUTION

3.1 SURVEYS

Perform surveys immediately prior to and after excavation of contaminated material to determine the volume of contaminated material removed. Also, perform surveys immediately after backfill of each excavation. Provide cross-sections on [25] [_____] foot intervals and at break points for all excavated areas. Survey and show locations of confirmation samples on the drawings. Perform surveys in accordance with Section: [_____].

3.2 EXISTING STRUCTURES AND UTILITIES

Do not perform excavation until site utilities have been field located. Take the necessary precautions to ensure no damage occurs to existing structures and utilities. Repair damage to existing structures and utilities resulting from the Contractor's operations at no additional cost to the Government. Do not disturb utilities encountered that were not previously shown or otherwise located without approval from the Contracting Officer.

3.3 CLEARING

Perform clearing to the limits shown on the drawings.

3.4 CONTAMINATED MATERIAL REMOVAL

3.4.1 Excavation

Excavate areas of contamination to the depth and extent shown on the drawings and not more than [0.2] [_____] ft beyond the depth and extent shown on the drawings unless directed by the Contracting Officer. Perform excavation in a manner that will limit spills and the potential for contaminated material to be mixed with uncontaminated material. Maintain an excavation log describing visible signs of contamination encountered for each area of excavation. Prepare excavation logs in accordance with ASTM D5434.

3.4.2 Shoring

If workers must enter the excavation, evaluate, shore, slope or brace it as required by EM 385-1-1 and 29 CFR 1926 section 650.

3.4.3 Dewatering

Divert surface water to prevent entry into the excavation. [Limit dewatering to that necessary to assure adequate access, a safe excavation, prevent the spread of contamination, and to ensure that compaction requirements can be met.] [Do not perform dewatering without prior approval of the Contracting Officer.]

3.5 CONFIRMATION SAMPLING AND ANALYSIS

The Contracting Officer will be present to inspect the removal of contaminated material from each site. After all material suspected of being contaminated has been removed, examine the excavation for evidence of contamination. If the excavation appears to be free of contamination, use field analysis to determine the presence of [_____] contamination

using [a real time vapor monitoring instrument] [immunoassay field kits] [____]. Excavate additional material as directed by the Contracting Officer. After all suspected contaminated material is removed, collect confirmation samples and analyze for the following contaminants:

Chemical Parameter	Action Level
[____]	[____]

Collect samples at a frequency of one per [____] square yards from the bottom [and each of the side walls] or as directed by the Contracting Officer. Collect a minimum of one sample from the bottom [and each side wall] of the excavation. Based on test results, propose any additional excavation which may be required to remove material which is contaminated above action levels. Additional excavation is subject to approval by the Contracting Officer. Mark locations of samples in the field and document on the as-built drawings.

3.6 CONTAMINATED MATERIAL STORAGE

Place material in temporary storage [immediately after excavation] [after treatment while awaiting test results]. The following paragraphs describe acceptable methods of material storage. Provide storage units that are in good condition and constructed of materials that are compatible with the material or liquid to be stored. If multiple storage units are required, clearly label each unit with an identification number and keep a written log to track the source of contaminated material in each temporary storage unit.

3.6.1 Stockpiles

Construct stockpiles to isolate stored contaminated material from the environment. Stockpile size greater than [____] cubic yards is prohibited. Construct stockpiles to include:

- [A chemically resistant geomembrane liner free of holes and other damage. Provide non-reinforced geomembrane liners that have a minimum thickness of [20] [____] mils. Provide scrim reinforced geomembrane liners that have a minimum weight of 40 lbs/1000 square feet. Place the geomembrane on a ground surface that is free of rocks greater than 0.5 inches in diameter and any other object which could damage the membrane.] [Use pavement as the liner system. Construct pavement in accordance with Section [____]].
- Geomembrane cover free of holes or other damage to prevent precipitation from entering the stockpile. Provide non-reinforced geomembrane covers that have a minimum thickness of 10 mils. Provide scrim reinforced geomembrane covers that have a minimum weight of 26 lbs/1000 square feet. Extend the cover material over the berms and anchor or ballast to prevent it from being removed or damaged by wind.
- Berms surrounding the stockpile, a minimum of 12 inches in height. Berm vehicle access points.
- Slope the liner system to allow collection of leachate. Storage and removal of liquid which collects in the stockpile, in accordance with paragraph Liquid Storage.

3.6.2 Roll-Off Units

Use water-tight roll-off units used to temporarily store contaminated material. Place a cover over the units to prevent precipitation from contacting the stored material. Locate the units [as shown on the drawings] [_____]. Remove liquid which collects inside the units and store in accordance with paragraph Liquid Storage.

3.6.3 Liquid Storage

Temporarily store liquid collected from excavations and stockpiles in [55 gallon barrels] [[500] [_____] gallon tanks]. Provide water-tight liquid storage containers and locate [as indicated] [_____].

3.7 SAMPLING

3.7.1 Sampling of Stored Material

Collect samples of stored material at a frequency of once per [_____] cubic yards. Test samples for the following:

Chemical Parameter	Action Level
[_____]	[_____]

Treat stored material with contaminant levels that exceed the action levels [offsite. Analyses for contaminated material to be taken to an offsite treatment facility must conform to local, state, and federal criteria as well as to the requirements of the treatment facility. Furnish documentation of all analyses performed to the Contracting Officer. Additional sampling and analyses to the extent required by the approved offsite treatment, storage or disposal (TSD) facility is the responsibility of the Contractor and must be [performed at no additional cost to the Government] [subject to approval by the Contracting Officer].] [onsite. Perform treatment in accordance with Section [_____].]

3.7.2 Sampling Liquid

Sample liquid collected from [excavations] [storage areas] [decontamination facilities] a frequency of once for every [500] [_____] gal of liquid collected. Test samples for the following:

Chemical Parameter	Action Level
[_____]	[_____]

Treat liquid with contaminant levels that exceed action levels [offsite. Analyses for contaminated liquid to be taken to an offsite treatment facility must conform to local, state, and federal criteria as well as to the requirements of the treatment facility. Furnish documentation of all analyses performed to the Contracting Officer. Additional sampling and analysis to the extent required by the approved offsite treatment, storage or disposal (TSD) facility receiving the material is the responsibility of the Contractor and must be [performed at no additional cost to the Government] [subject to approval by the Contracting Officer].] [onsite. Perform treatment accordance with Section [_____].]

3.7.3 Sampling Beneath Storage Units

Collect samples from beneath each storage unit prior to construction of and after removal of the storage unit. Collect samples at a frequency of one per each [_____] square yards from a depth interval of [0 to 0.5] [_____] feet and test for the following:

Chemical Parameter	Action Level
[_____]	[_____]

Based on test results, remove soil which has become contaminated above action levels at no additional cost to the Government. Handle contaminated material which is removed from beneath the storage unit in accordance with paragraph Sampling of Stored Material. As directed by the Contracting Officer and at no additional cost to the Government, perform additional sampling and testing to verify areas of contamination found beneath stockpiles have been cleaned up to below action levels.

3.8 SPILLS

In the event of a spill or release of a hazardous substance (as designated in 40 CFR 302), pollutant, contaminant, or oil (as governed by the Oil Pollution Act (OPA), 33 U.S.C. 2701 et seq.), notify the Contracting Officer immediately. If the spill exceeds the reporting threshold, follow the pre-established procedures as described in the [RCRA Contingency Plan] [Base Wide Contingency Plan] [_____] for immediate reporting and containment. Take immediate containment actions to minimize the effect of any spill or leak. Perform cleanup in accordance with applicable federal, state, and local regulations. As directed by the Contracting Officer, perform additional sampling and testing to verify spills have been cleaned up. Perform spill cleanup and testing at no additional cost to the Government.

3.9 BACKFILLING

3.9.1 Confirmation Test Results

Backfill excavations immediately after all contaminated materials have been removed and confirmation test results have been approved. Place and compact backfill to the lines and grades shown on the drawings.

3.9.2 Compaction

Place approved backfill in lifts with a maximum loose thickness of [8] [_____] inches. Compact soil to [90] [_____] percent of [ASTM D698] [ASTM D1557] maximum dry density. Perform density tests at a frequency of once per [10,000] [_____] square feet per lift. conduct a minimum of [one density test] [[_____] density tests] on each lift of backfill placed. Determine field in-place dry density in accordance with ASTM D1556/D1556M, ASTM D2167, or ASTM D6938. If ASTM D6938 is used, check a minimum of one in ten tests using ASTM D1556/D1556M or ASTM D2167. Test results from ASTM D1556/D1556M or ASTM D2167 will govern if there is a discrepancy with the ASTM D6938 test results.

3.10 DISPOSAL REQUIREMENTS

Perform offsite disposal of contaminated material

3.11 CLOSURE REPORT

Submit [_____] copies of a Closure Report within [14] [_____] calendar days of completing work at the site. Label the report with the contract number, project name, location, date, name of general Contractor, and the Corps of Engineers District contracting for the work. As a minimum, include the following information:

- a. A cover letter signed by a [responsible company official] [Professional Engineer registered in the State of [_____] who is a responsible company official] certifying that all services involved have been performed in accordance with the terms and conditions of the contract documents and regulatory requirements.
- b. A narrative report including, but not limited to, the following:
 - (1) site conditions, ground water elevation, and cleanup criteria;
 - (2) excavation logs;
 - (3) field screening readings;
 - (4) quantity of materials removed from each area of contamination;
 - (5) quantity of water/product removed during dewatering;
 - (6) sampling locations and sampling methods;
 - (7) sample collection data such as time of collection and method of preservation;
 - (8) sample chain-of-custody forms; and
 - (9) source of backfill.
- c. Copies of all chemical and physical test results.
- d. Copies of all manifests and land disposal restriction notifications.
- e. Copies of all certifications of final disposal signed by the responsible disposal facility official.
- f. Waste profile sheets.
- g. Scale drawings showing limits of each excavation, limits of contamination, known underground utilities within 50 feet of excavation, sample locations, and sample identification numbers. Show on-site stockpile, storage, treatment, loading, and disposal areas on the drawings.
- h. Progress Photographs. Use color photographs to document progress of the work. Take a minimum of four views of the site showing the location of the area of contamination, entrance/exit road, and any other notable site conditions before work begins. After work has been started, photographically record [daily] [weekly] activities at each work location. Provide photographs that are a minimum of 3 by 5 inches and include:

- (1) Soil removal and sampling.
- (2) Dewatering operations.
- (3) Unanticipated events such as spills and the discovery of additional contaminated material.
- (4) Contaminated material/water storage, handling, treatment, and transport.
- (5) Site or task-specific employee respiratory and personal protection.
- (6) Fill placement and grading.
- (7) Post-construction photographs. After completion of work at each site, take a minimum of four views of each excavation site.

Include a digital version of all photos shown in the report with the Closure Report. Provide photographs that are a minimum of 3 inches by 5 inches and mount back-to-back in double face plastic sleeves punched to fit standard three ring binders. Attach an information box to each print. Arrange the typewritten box as follows:

Project Name:	Direction of View:
Location:	Date/Time:
Photograph No.:	Description of View:

-- End of Section --

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SECTION 02 82 00

ASBESTOS REMEDIATION
11/18, CHG 1: 11/19

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF SAFETY PROFESSIONALS (ASSP)

ASSP Z9.2 (2018) Fundamentals Governing the Design and Operation of Local Exhaust Ventilation Systems

ASTM INTERNATIONAL (ASTM)

ASTM D4397 (2016) Standard Specification for Polyethylene Sheeting for Construction, Industrial, and Agricultural Applications

ASTM E1368 (2014) Visual Inspection of Asbestos Abatement Projects

COMPRESSED GAS ASSOCIATION (CGA)

CGA G-7 (2014) Compressed Air for Human Respiration; 6th Edition

INTERNATIONAL SAFETY EQUIPMENT ASSOCIATION (ISEA)

ANSI/ISEA Z87.1 (2020) Occupational and Educational Personal Eye and Face Protection Devices

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 701 (2019) Standard Methods of Fire Tests for Flame Propagation of Textiles and Films

NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH (NIOSH)

NIOSH NMAM (2016; 5th Ed) NIOSH Manual of Analytical Methods

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1 (2014) Safety -- Safety and Health Requirements Manual

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA 340/1-90/018 (1990) Asbestos/NESHAP Regulated Asbestos Containing Materials Guidance

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1926.51	Sanitation
29 CFR 1926.59	Hazard Communication
29 CFR 1926.103	Respiratory Protection
29 CFR 1926.200	Accident Prevention Signs and Tags
29 CFR 1926.1101	Asbestos
40 CFR 61-SUBPART A	General Provisions
40 CFR 61-SUBPART M	National Emission Standard for Asbestos
40 CFR 763	Asbestos
42 CFR 84	Approval of Respiratory Protective Devices
49 CFR 107	Hazardous Materials Program Procedures
49 CFR 171	General Information, Regulations, and Definitions
49 CFR 172	Hazardous Materials Table, Special Provisions, Hazardous Materials Communications, Emergency Response Information, and Training Requirements
49 CFR 173	Shippers - General Requirements for Shipments and Packagings

U.S. NAVAL FACILITIES ENGINEERING COMMAND (NAVFAC)

NAVFAC P-502	(2017) Asbestos Program Management
ND OPNAVINST 5100.23	(2005; Rev G) Navy Occupational Safety and Health (NAVOSH) Program Manual

UNDERWRITERS LABORATORIES (UL)

UL 586	(2009; Reprint Sep 2022) UL Standard for Safety High-Efficiency Particulate, Air Filter Units

1.2 DEFINITIONS

1.2.1 APOC

MAFB Asbestos Point of Contact, located at the Maxwell Environmental Section, Base Environmental Office 42 CES/CEIE); 334-953-5260 during duty hours and 334-953-3333 during off hours.

1.2.2 ACM

Asbestos Containing Materials.

1.2.3 Amended Water

Water containing a wetting agent or surfactant with a maximum surface tension of 0.00042 psi.

1.2.4 Area Sampling

Sampling of asbestos fiber concentrations which approximates the concentrations of asbestos in the theoretical breathing zone but is not actually collected in the breathing zone of an employee.

1.2.5 Asbestos

The term asbestos includes chrysotile, amosite, crocidolite, tremolite asbestos, anthophyllite asbestos, and actinolite asbestos and any of these minerals that has been chemically treated or altered. Materials are considered to contain asbestos if the asbestos content of the material is determined to be at least one percent.

1.2.6 Asbestos Control Area

That area where asbestos removal operations are performed which is isolated by physical boundaries which assist in the prevention of the uncontrolled release of asbestos dust, fibers, or debris.

1.2.7 Asbestos Fibers

Those fibers having an aspect ratio of at least 3:1 and longer than 5 micrometers as determined by National Institute for Occupational Safety and Health (NIOSH) Method 7400.

1.2.8 Asbestos Permissible Exposure Limit

0.1 fibers per cubic centimeter of air as an 8-hour time weighted average measured in the breathing zone as defined by 29 CFR 1926.1101 or other Federal legislation having legal jurisdiction for the protection of workers health.

1.2.9 Authorized Person

Any person authorized by the Contractor and required by work duties to be present in the regulated areas.

1.2.10 Background

The ambient airborne asbestos concentration in an uncontaminated area as measured prior to any asbestos hazard abatement efforts. Background concentrations for other (contaminated) areas are measured in similar but asbestos free locations.

1.2.11 Competent Person (CP)

A person meeting the requirements for competent person as specified in 29 CFR 1926.1101 including a person capable of identifying existing asbestos hazards in the workplace and selecting the appropriate control strategy for asbestos exposure, who has the authority to take prompt corrective measures to eliminate them, and is specifically trained in a training course which meet the criteria of EPA's Model Accreditation Plan (40 CFR 763) for project designer or supervisor, or its equivalent. The

competent person must have a current State of **Alabama** asbestos contractors or supervisors license.

1.2.12 Contractor

The Contractor is that individual, or entity under contract to perform the herein listed work.

1.2.13 Disposal Bag

A **6 mil** thick, leak-tight plastic bag, pre-labeled in accordance with **29 CFR 1926.1101**, used for transporting asbestos waste from containment to disposal site.

1.2.14 Disturbance

Activities that disrupt the matrix of ACM, crumble or pulverize ACM, or generate visible debris from ACM. Disturbance includes cutting away small amounts of ACM, no greater than the amount which can be contained in one standard sized glovebag or waste bag, not larger than **60 inches** in length and width in order to access a building component.

1.2.15 Encapsulation

The abatement of an asbestos hazard through the appropriate use of chemical encapsulants.

1.2.16 Encapsulants

Specific materials in various forms used to chemically or physically entrap asbestos fibers in various configurations to prevent these fibers from becoming airborne. There are four types of encapsulants as follows which must comply with performance requirements as specified herein.

- a. Removal Encapsulant (can be used as a wetting agent)
- b. Bridging Encapsulant (used to provide a tough, durable surface coating to asbestos containing material)
- c. Penetrating Encapsulant (used to penetrate the asbestos containing material encapsulating all asbestos fibers and preventing fiber release due to routine mechanical damage)
- d. Lock-Down Encapsulant (used to seal off or "lock-down" minute asbestos fibers left on surfaces from which asbestos containing material has been removed).

1.2.17 Friable Asbestos Material

A term defined in **40 CFR 61-SUBPART M** and **EPA 340/1-90/018** meaning any material which contains more than 1 percent asbestos, as determined using the method specified in **40 CFR 763**, Polarized Light Microscopy (PLM), that when dry, can be crumbled, pulverized, or reduced to powder by hand pressure.

1.2.18 Glovebag Technique

Those asbestos removal and control techniques put forth in **29 CFR 1926.1101**.

1.2.19 Government Consultant (GC)

That qualified person employed directly by the Government to monitor, sample, inspect the work or in some other way advise the Contracting Officer. The GC is normally a private consultant, but can be an employee of the Government.

1.2.20 HEPA Filter Equipment

High efficiency particulate air (HEPA) filtered vacuum and exhaust ventilation equipment with a filter system capable of collecting and retaining asbestos fibers. Filters must retain 99.97 percent of particles 0.3 microns or larger as indicated in [UL 586](#).

1.2.21 Model Accreditation Plan (MAP)

USEPA training accreditation requirements for persons who work with asbestos as specified in [40 CFR 763](#).

1.2.22 Negative Pressure Enclosure (NPE)

That engineering control technique described as a negative pressure enclosure in [29 CFR 1926.1101](#).

1.2.23 NESHAP

National Emission Standards for Hazardous Air Pollutants. The USEPA NESHAP regulation for asbestos is at [40 CFR 61-SUBPART M](#).

1.2.24 Nonfriable Asbestos Material

Material that contains asbestos in which the fibers have been immobilized by a bonding agent, coating, binder, or other material so that the asbestos is well bound and will not normally release asbestos fibers during any appropriate use, handling, storage or transportation. It is understood that asbestos fibers may be released under other conditions such as demolition, removal, or mishap.

1.2.25 Permissible Exposure Limits (PELs)

1.2.25.1 PEL-Time Weighted Average(TWA)

Concentration of asbestos not in excess of 0.1 fibers per cubic centimeter of air (f/cc) as an 8-hour time weighted average (TWA).

1.2.25.2 PEL-Excursion Limit

An airborne concentration of asbestos not in excess of 1.0 f/cc of air as averaged over a sampling period of 30 minutes.

1.2.26 Personal Sampling

Air sampling which is performed to determine asbestos fiber concentrations within the breathing zone of a specific employee, as performed in accordance with [29 CFR 1926.1101](#).

1.2.27 Private Qualified Person (PQP)

That qualified person hired by the Contractor to perform the herein listed

tasks.

1.2.28 Qualified Person (QP)

A Registered Architect, Professional Engineer, Certified Industrial Hygienist, consultant or other qualified person who has successfully completed training and is therefore accredited under a legitimate State Model Accreditation Plan as described in [40 CFR 763](#) as a Building Inspector, Contractor/Supervisor Abatement Worker, and Asbestos Project Designer; and has successfully completed the National Institute of Occupational Safety and Health (NIOSH) 582 course "Sampling and Evaluating Airborne Asbestos Dust" or equivalent. The QP must be qualified to perform visual inspections as indicated in [ASTM E1368](#). The QP must be appropriately licensed in the State of [Alabama](#).

1.2.29 TEM

Refers to Transmission Electron Microscopy.

1.2.30 Time Weighted Average (TWA)

The TWA is an 8-hour time weighted average airborne concentration of asbestos fibers.

1.2.31 Transite

A generic name for asbestos cement wallboard and pipe.

1.2.32 Wetting Agent

A chemical added to water to reduce the water's surface tension thereby increasing the water's ability to soak into the material to which it is applied. An equivalent wetting agent must have a surface tension of at most [0.00042 psi](#).

1.2.33 Worker

Individual (not designated as the Competent Person or a supervisor) who performs asbestos work and has completed asbestos worker training required by [29 CFR 1926.1101](#), to include EPA Model Accreditation Plan (MAP) "Worker" training; accreditation, if required by the OSHA Class of work to be performed or by the state where the work is to be performed. The worker must be appropriately licensed in the State of [Alabama](#).

1.3 REQUIREMENTS

1.3.1 Description of Work

[Upon discovery of possible asbestos materials, work is required to stop and contact made with APOC for verification. Upon verification by the APOC of the presence of asbestos, the requirements of this section are in effect. NO ABATEMENT WORK IS TO BEGIN WITHOUT APPROVAL FROM THE APOC.](#)

The work covered by this section includes the handling and control of asbestos containing materials and describes some of the resultant procedures and equipment required to protect workers, the environment and occupants of the building or area, or both, from contact with airborne asbestos fibers. The work also includes the disposal of any asbestos containing materials generated by the work. More specific operational

procedures must be outlined in the Asbestos Hazard Abatement Plan called for elsewhere in this specification. The asbestos work includes the demolition and removal of **asbestos materials** located **within the area of demolition** which is governed by **40 CFR 763** and **NAVFAC P-502**. Under normal conditions non-friable or chemically bound materials containing asbestos would not be considered hazardous; however, this material may release airborne asbestos fibers during demolition and removal and therefore must be handled in accordance with the removal and disposal procedures as specified herein. Provide techniques as outlined in this specification. The work area will be evacuated during the asbestos abatement work. A competent person must supervise asbestos removal work as specified herein.

1.3.2 Unexpected Discovery of Asbestos

Notify the Contracting Officer if any previously untested building components suspected to contain asbestos are impacted by the work.

1.3.3 Medical Requirements

Provide medical requirements including but not limited to medical surveillance and medical record keeping as listed in **29 CFR 1926.1101**.

1.3.3.1 Medical Examinations

Before exposure to airborne asbestos fibers, provide workers with a comprehensive medical examination as required by **29 CFR 1926.1101** or other pertinent State or local directives. This requirement must have been satisfied within the 12 months prior to the start of work on this contract. The same medical examination must be given on an annual basis to employees engaged in an occupation involving asbestos and within 30 calendar days before or after the termination of employment in such occupation. Specifically identify x-ray films of asbestos workers to the consulting radiologist and mark medical record jackets with the word "ASBESTOS."

1.3.3.2 Medical Records

Maintain complete and accurate records of employees' medical examinations, medical records, and exposure data for a period of 50 years after termination of employment and make records of the required medical examinations and exposure data available for inspection and copying to: The Assistant Secretary of Labor for Occupational Safety and Health (OSHA), or authorized representatives of them, and an employee's physician upon the request of the employee or former employee.

1.3.4 Employee Training

Submit certificates, prior to the start of work but after the main abatement submittal, signed by each employee indicating that the employee has received training in the proper handling of materials and wastes that contain asbestos in accordance with **40 CFR 763**; understands the health implications and risks involved, including the illnesses possible from exposure to airborne asbestos fibers; understands the use and limits of the respiratory equipment to be used; and understands the results of monitoring of airborne quantities of asbestos as related to health and respiratory equipment as indicated in **29 CFR 1926.1101** on an initial and annual basis. Organize certificates by individual worker, not grouped by type of certification. Post appropriate evidence of compliance with the training requirements of **40 CFR 763**. Train personnel involved in the

asbestos control work in accordance with United States Environmental Protection Agency (USEPA) Asbestos Hazard Emergency Response Act (AHERA) training criteria or State training criteria whichever is more stringent. Document the training by providing: dates of training, training entity, course outline, names of instructors, and qualifications of instructors upon request by the Contracting Officer. Furnish each employee with respirator training and fit testing administered by the PQP as required by 29 CFR 1926.1101 and 29 CFR 1926.103. Fully cover engineering and other hazard control techniques and procedures. Asbestos workers must have a current State of Alabama asbestos worker's license.

1.3.5 Permits, Licenses, and Notifications

Prior to the start of work, obtain necessary permits and licenses in conjunction with asbestos removal, encapsulation, hauling, and disposition, and furnish notification of such actions required by Federal, State, regional, and local authorities. Notify the State's environmental protection agency and Base Environmental Office and the Contracting Officer in writing 10 working days prior to commencement of work in accordance with 40 CFR 61-SUBPART M and the Maxwell Air Force Base Asbestos Management and Operations Plan. Notify the Contracting Officer and other appropriate Government agencies in writing 20 working days prior to the start of asbestos work as indicated in applicable laws, ordinances, criteria, rules, and regulations. Submit copies of all Notifications to the Contracting Officer.

1.3.6 Environment, Safety and Health Compliance

In addition to detailed requirements of this specification, comply with those applicable laws, ordinances, criteria, rules, and regulations of Federal, State, regional, and local authorities regarding handling, storing, transporting, and disposing of asbestos waste materials. Comply with the applicable requirements of the current issue of EM 385-1-1, 29 CFR 1926.1101, 40 CFR 61-SUBPART A, 40 CFR 61-SUBPART M, 40 CFR 763 and ND OPNAVINST 5100.23. Submit matters of interpretation of standards to the appropriate administrative agency for resolution before starting the work. Where the requirements of this specification, applicable laws, rules, criteria, ordinances, regulations, and referenced documents vary, the most stringent requirement as defined by the Government apply. The following laws, ordinances, criteria, rules and regulations regarding removal, handling, storing, transporting and disposing of asbestos materials apply:

- a. Maxwell Air Force Base Asbestos Management and Operations Plan
- b. Alabama Department of Environmental Management (ADEM)

1.3.7 Respiratory Protection Program

Establish and implement a respirator program as required by 29 CFR 1926.1101, and 29 CFR 1926.103. Submit a written description of the program to the Contracting Officer. Submit a written program manual or operating procedure including methods of compliance with regulatory statutes.

1.3.7.1 Respirator Program Records

Submit records of the respirator program as required by 29 CFR 1926.103, and 29 CFR 1926.1101.

1.3.7.2 Respirator Fit Testing

The Contractor's PQP must conduct a qualitative or quantitative fit test conforming to 29 CFR 1926.103 for each worker required to wear a respirator, and any authorized visitors who enter a regulated area where respirators are required to be worn. A respirator fit test must be performed prior to initially wearing a respirator and every 12 months thereafter. If physical changes develop that will affect the fit, a new fit test must be performed. Functional fit checks must be performed each time a respirator is put on and in accordance with the manufacturer's recommendation.

1.3.7.3 Respirator Selection and Use Requirements

Provide respirators, and ensure that they are used as required by 29 CFR 1926.1101 and in accordance with CGA G-7 and the manufacturer's recommendations. Respirators must be approved by the National Institute for Occupational Safety and Health NIOSH, under the provisions of 42 CFR 84, for use in environments containing airborne asbestos fibers. For air-purifying respirators, the particulate filter must be high-efficiency particulate air (HEPA)/(N-,R-,P-100). The initial respirator selection and the decisions regarding the upgrading or downgrading of respirator type must be made by the Contractor's Designated IH based on the measured or anticipated airborne asbestos fiber concentrations to be encountered.

1.3.8 Asbestos Hazard Control Supervisor

The Contractor must be represented on site by a supervisor, trained using the model Contractor accreditation plan as indicated in the Federal statutes for all portions of the herein listed work.

1.3.9 Hazard Communication

Adhere to all parts of 29 CFR 1926.59 and provide the Contracting Officer with a copy of the Safety Data Sheets (SDS) for all materials brought to the site.

1.3.10 Asbestos Hazard Abatement Plan

Submit a detailed plan of the safety precautions such as lockout, tagout, tryout, fall protection, and confined space entry procedures and equipment and work procedures to be used in the removal of materials containing asbestos. The plan, not to be combined with other hazard abatement plans, must be prepared, reviewed and signed by a Certified Industrial Hygienist (CIH) and/or by a State of Alabama Accredited Asbestos Designer. Provide a Table of Contents for each abatement submittal, which follows the sequence of requirements in the contract. The plan must include but not be limited to the precise personal protective equipment to be used including, but not limited to, respiratory protection, type of whole-body protection, the location of asbestos control areas including clean and dirty areas, buffer zones, showers, storage areas, change rooms, removal method, interface of trades involved in the construction, sequencing of asbestos related work, disposal plan, type of wetting agent and asbestos sealer to be used, locations of local exhaust equipment, planned air monitoring strategies, and a detailed description of the method to be employed in order to control environmental pollution. The plan must also include (both fire and medical emergency) response plans and an Activity Hazard Analyses (AHAs) in accordance with EM 385-1-1. The Asbestos Hazard

Abatement Plan must be approved in writing by the APOC prior to starting any asbestos work. The Contractor, Asbestos Hazard Control Supervisor, CP and PQP must meet with the Contracting Officer prior to beginning work, to discuss in detail the Asbestos Hazard Abatement Plan, including work procedures and safety precautions. Once approved by the Contracting Officer, the plan will be enforced as if an addition to the specification. Any changes required in the specification as a result of the plan must be identified specifically in the plan to allow for free discussion and approval by the Contracting Officer prior to starting work.

1.3.11 Testing Laboratory

Submit the name, address, and telephone number of each testing laboratory selected for the sampling, analysis, and reporting of airborne concentrations of asbestos fibers along with evidence that each laboratory selected holds the appropriate State license and permits and certification that each laboratory is American Industrial Hygiene Association (AIHA) accredited and that persons counting the samples have been judged proficient by current inclusion on the AIHA Asbestos Analysis Registry (AAR) and successful participation of the laboratory in the Proficiency Analytical Testing (PAT) Program. Where analysis to determine asbestos content in bulk materials or transmission electron microscopy is required, submit evidence that the laboratory is accredited by the National Institute of Science and Technology (NIST) under National Voluntary Laboratory Accreditation Program (NVLAP) for asbestos analysis. The testing laboratory firm must be independent of the asbestos contractor and must have no employee or employer relationship which could constitute a conflict of interest.

1.3.12 Landfill Approval

Submit written evidence that the landfill is approved for asbestos disposal by the ADEM and local regulatory agencies. Within three working days after delivery, submit detailed delivery tickets, prepared, signed, and dated by an agent of the landfill, certifying the amount of asbestos materials delivered to the landfill. Submit a copy of the waste shipment records within one day of the shipment leaving the project site.

1.3.13 Transporter Certification

Submit written evidence that the transporter is approved to transport asbestos waste in accordance with the DOT requirements of 49 CFR 171, 49 CFR 172 and 49 CFR 173 as well as registration requirements of 49 CFR 107 and all other State and local regulatory agency requirements.

1.3.14 Medical Certification

Provide a written certification for each worker and supervisor, signed by a licensed physician indicating that the worker and supervisor has met or exceeded all of the medical prerequisites listed herein and in 29 CFR 1926.1101 and 29 CFR 1926.103 as prescribed by law. Submit certificates prior to the start of work but after the main abatement submittal.

1.4 SUBMITTALS

Government approval is required for submittals. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Amended Water

Safety Data Sheets (SDS) for All Materials

Respirators

Local Exhaust Equipment

Pressure Differential Automatic Recording Instrument

Vacuums

SD-06 Test Reports

Air Sampling Results

Pressure Differential Recordings for Local Exhaust System

Clearance Sampling

Asbestos Disposal Quantity Report

SD-07 Certificates

Employee Training

Notifications

Respiratory Protection Program

Asbestos Hazard Abatement Plan

Testing Laboratory

Landfill Approval

Delivery Tickets

Waste Shipment Records

Transporter Certification

Medical Certification

Private Qualified Person Documentation

Designated Competent Person

Worker's License

Contractor's License

Federal, State or Local Citations on Previous Projects

Equipment Used to Contain Airborne Asbestos Fibers

Water Filtration Equipment

Vacuums

Ventilation Systems

Glovebags

SD-11 Closeout Submittals

Permits and Licenses

Notifications

Respirator Program Records

Protective Clothing Decontamination Quality Control Records

Protective Clothing Decontamination Facility Notification

Rental Equipment

Air Sampling Analytical Results

Daily Report Log

Daily Worker Sign-In/Out Sheets

Waste Manifest

Safe State Certificates

1.5 QUALITY ASSURANCE

All asbestos-containing materials, friable and non-friable categories are included with the Maxwell-Gunter AFB asbestos requirements. All handling and disposal requirements shall follow State requirements. This includes labeling of removed/abated materials and copies of all executed waste manifests from a permitted landfill

1.5.1 Private Qualified Person Documentation

Submit the name, address, and telephone number of the Private Qualified Person (PQP) selected to prepare the Asbestos Hazard Abatement Plan, direct monitoring and training, and documented evidence that the PQP has successfully completed training in and is accredited and where required is certified as, a Building Inspector, Contractor/Supervisor Abatement Worker, and Asbestos Project Designer as described by 40 CFR 763 and has successfully completed the National Institute of Occupational Safety and Health (NIOSH) 582 course "Sampling and Evaluating Airborne Asbestos Dust" or equivalent. The PQP must be appropriately licensed in the State of Alabama as a Project Monitor. The PQP and the asbestos contractor must not have an employee/employer relationship or financial relationship which could constitute a conflict of interest. The PQP must be a first tier subcontractor.

1.5.2 Designated Competent Person Documentation

The Designated Competent Person must be experienced in the administration and supervision of asbestos abatement projects including exposure assessment and monitoring, work practices, abatement methods, protective

measures for personnel, setting up and inspecting asbestos abatement work areas, evaluating the integrity of containment barriers, placement and operation of local exhaust systems, ACM generated waste containment and disposal procedures, decontamination units installation and maintenance requirements, site safety and health requirements, notification of other employees onsite. The Designated Competent Person must be on-site at all times when asbestos abatement activities are underway. Submit training certification and a current State of [Alabama](#) Asbestos Contractor's and Supervisor's License. Submit evidence that the Designated Competent Person has a minimum of 2 years of on-the-job asbestos abatement experience relevant to OSHA designated competent person requirements. The Designated Competent Person must be a first tier subcontractor.

1.5.3 Worker's License

All workers and supervisors must be certified by the Alabama's Safe State Program. Submit documentation that workers meet the requirements of [29 CFR 1926.1101](#), [40 CFR 61-SUBPART M](#) and have a current State of [Alabama](#) Asbestos Workers License.

1.5.4 Contractor's License

An Alabama Department of Environmental Management (ADEM) certified asbestos abatement contractor is required to conduct all asbestos removal/abatement activities. Submit a copy of the asbestos contractor's license issued by the State of [Alabama](#). Submit the following certification along with the license: "I certify that the personnel I am responsible for during the course of this project fully understand the contents of [29 CFR 1926.1101](#), [40 CFR 61-SUBPART MEM 385-1-1](#), and the Federal, State and local requirements for those asbestos abatement activities that they will be involved in." This certification statement must be signed by the Company's President or Chief Executive.

1.5.5 Asbestos Hazard Abatement Plan

Submit an Asbestos Hazard Abatement Plan that has been reviewed and signed by a Certified Industrial Hygienist (CIH) and/or by a State of Alabama Accredited Asbestos Designer

1.5.6 Air Sampling Results

Complete fiber counting and provide results to the [APOC](#) for review within 16 hours of the "time off" of the sample pump. Notify the Contracting Officer immediately of any airborne levels of asbestos fibers in excess of the acceptable limits. Submit sampling results to the Contracting Officer and the affected Contractor employees where required by law within three working days, signed by the testing laboratory employee performing air sampling, the employee that analyzed the sample, and the [APOC](#). Notify the Contractor and the Contracting Officer immediately of any variance in the pressure differential which could cause adjacent unsealed areas to have asbestos fiber concentrations in excess of 0.01 fibers per cubic centimeter or background whichever is higher. In no circumstance must levels exceed 0.1 fibers per cubic centimeter.

1.5.7 Pressure Differential Recordings for Local Exhaust System

Provide a local exhaust system that creates a negative pressure of at least [0.02 inches](#) of water relative to the pressure external to the enclosure and operate it continuously, 24-hours a day, until the temporary enclosure

of the asbestos control area is removed. Submit pressure differential recordings for each work day to the APOC for review and to the Contracting Officer within 24-hours from the end of each work day.

1.5.8 Protective Clothing Decontamination Quality Control Records

Provide all records that document quality control for the decontamination of reusable outer protective clothing.

1.5.9 Protective Clothing Decontamination Facility Notification

Submit written evidence that persons who decontaminate, store, or transport asbestos contaminated clothing used in the performance of this contract were duly notified in accordance with 29 CFR 1926.1101.

1.5.10 Federal, State or Local Citations on Previous Projects

Submit a statement, signed by an officer of the company, containing a record of any citations issued by Federal, State or local regulatory agencies relating to asbestos activities within the last 5 years (including projects, dates, and resolutions); a list of penalties incurred through non-compliance with asbestos project specifications, including liquidated damages, overruns in scheduled time limitations and resolutions; and situations in which an asbestos-related contract has been terminated (including projects, dates, and reasons for terminations). If there are none, a negative declaration signed by an officer of the company must be provided.

1.5.11 Preconstruction Conference

Conduct a safety preconstruction conference to discuss the details of the Asbestos Hazard Abatement Plan, Accident Prevention Plan (APP) including the AHAs required.

The safety pre-construction conference must include the Contractor and their Designated Competent Person, Designated IH and Project Supervisor, the APOC, and the Contracting Officer. Deficiencies in the APP will be discussed. Onsite work must not begin until the APP has been accepted.

1.6 SECURITY

A log book must be kept documenting entry into and out of the regulated area. Entry into regulated areas must only be by personnel authorized by the Contractor and the Contracting Officer. Personnel authorized to enter regulated areas must be trained, medically evaluated, and wear the required personal protective equipment.

1.7 EQUIPMENT

1.7.1 Rental Equipment

Provide a copy of the written notification to the rental company concerning the intended use of the equipment and the possibility of asbestos contamination of the equipment.

PART 2 PRODUCTS

2.1 DUCT TAPE

Industrial grade duct tape of appropriate widths suitable for bonding sheet plastic and disposal container.

2.2 DISPOSAL CONTAINERS

Leak-tight (defined as solids, liquids, or dust that cannot escape or spill out) disposal containers must be provided for ACM wastes as required by 29 CFR 1926.1101. Disposal containers can be in the form of:

- a. Disposal Bags
- b. Fiberboard Drums
- c. Cardboard Boxes

2.3 SHEET PLASTIC

Sheet plastic must be polyethylene of 6 mil minimum thickness and must be provided in the largest sheet size necessary to minimize seams. Film must be frosted and conform to ASTM D4397, except as specified below

2.3.1 Flame Resistant

Where a potential for fire exists, flame-resistant sheets must be provided. Film must be frosted and must conform to the requirements of NFPA 701.

2.3.2 Reinforced

Reinforced sheets must be provided where high skin strength is required, such as where it constitutes the only barrier between the regulated area and the outdoor environment. The sheet stock must consist of translucent, nylon-reinforced or woven-polyethylene thread laminated between 2 layers of polyethylene film. Film must meet flame resistant standards of NFPA 701.

2.4 MASTIC REMOVING SOLVENT

Mastic removing solvent must be nonflammable and must not contain methylene chloride, glycol ether, or halogenated hydrocarbons. Solvents used onsite must have a flash point greater than 140 degrees F.

2.5 LEAK-TIGHT WRAPPING

Two layers of 6 mil minimum thick polyethylene sheet stock must be used for the containment of removed asbestos-containing components or materials such as large tanks, boilers, insulated pipe segments and other materials. Upon placement of the ACM component or material, each layer must be individually leak-tight sealed with duct tape.

2.6 VIEWING INSPECTION WINDOW

Where feasible, a minimum of one clear, 1/8 inch thick, acrylic sheet, 18 by 24 inches, must be installed as a viewing inspection window at eye level on a wall in each containment enclosure. The windows must be sealed leak-tight with industrial grade duct tape.

2.7 WETTING AGENTS

Removal encapsulant (a penetrating encapsulant) must be provided when conducting removal abatement activities that require a longer removal time or are subject to rapid evaporation of amended water. The removal encapsulant must be capable of wetting the ACM and retarding fiber release during disturbance of the ACM greater than or equal to that provided by amended water. Performance requirements for penetrating encapsulants are specified in paragraph ENCAPSULANTS above.

PART 3 EXECUTION

3.1 EQUIPMENT

Provide the Contracting Officer or the APOC, with at least two complete sets of personal protective equipment as required for entry to and inspection of the asbestos control area. Provide equivalent training to the Contracting Officer or a designated representative as provided to Contractor employees in the use of the required personal protective equipment. Provide manufacturer's certificate of compliance for all equipment used to contain airborne asbestos fibers.

3.1.1 Air Monitoring Equipment

The Contractor's PQP must approve air monitoring equipment. The equipment must include, but must not be limited to:

- a. High-volume sampling pumps that can be calibrated and operated at a constant airflow up to 16 liters per minute.
- b. Low-volume, battery powered, body-attachable, portable personal pumps that can be calibrated to a constant airflow up to approximately 3.5 liters per minute, and a self-contained rechargeable power pack capable of sustaining the calibrated flow rate for a minimum of 10 hours. The pumps must also be equipped with an automatic flow control unit which must maintain a constant flow, even as filter resistance increases due to accumulation of fiber and debris on the filter surface.
- c. Single use standard 25 mm diameter cassette, open face, 0.8 micron pore size, mixed cellulose ester membrane filters and cassettes with 50 mm electrically conductive extension cowl, and shrink bands for personal air sampling.
- d. A flow calibrator capable of calibration to within plus or minus 2 percent of reading over a temperature range of minus 4 to plus 140 degrees F and traceable to a NIST primary standard.

3.1.2 Respirators

Select respirators from those approved by the National Institute for Occupational Safety and Health (NIOSH), Department of Health and Human Services.

3.1.2.1 Respirators for Handling Asbestos

Provide personnel engaged in pre-cleaning, cleanup, handling, removal of asbestos materials with respiratory protection as indicated in

29 CFR 1926.1101 and 29 CFR 1926.103. Breathing air must comply with CGA G-7.

3.1.3 Exterior Whole Body Protection

3.1.3.1 Outer Protective Clothing

Provide personnel exposed to asbestos with disposable "non-breathable," or reusable "non-breathable" whole body outer protective clothing, head coverings, gloves, and foot coverings. Provide disposable plastic or rubber gloves to protect hands. Cloth gloves may be worn inside the plastic or rubber gloves for comfort, but must not be used alone. Make sleeves secure at the wrists, make foot coverings secure at the ankles, and make clothing secure at the neck by the use of tape. Reusable whole body outer protective clothing must be either disposed of as asbestos contaminated waste upon exiting from the asbestos regulated work area or be properly decontaminated.

3.1.3.2 Work Clothing

Provide cloth work clothes for wear under the outer protective clothing and foot coverings and either dispose of or properly decontaminate them as recommended by the APOC after each use.

3.1.3.3 Personal Decontamination Unit

Provide a temporary, negative pressure unit with a separate decontamination locker room and clean locker room with a shower that complies with 29 CFR 1926.51(f)(4)(ii) through (V) in between for personnel required to wear whole body protective clothing. Provide two separate lockers for each asbestos worker, one in each locker room. Keep street clothing and street shoes in the clean locker. HEPA vacuum and remove asbestos contaminated disposable protective clothing while still wearing respirators at the boundary of the asbestos work area and seal in impermeable bags or containers for disposal. Do not wear work clothing between home and work. Locate showers between the decontamination locker room and the clean locker room and require that all employees shower before changing into street clothes. Collect used shower water and filter with approved water filtration equipment to remove asbestos contamination. Wastewater filters must be installed in series with the first stage pore size 20 microns and the second stage pore size of 5 microns. Dispose of filters and residue as asbestos waste. Discharge clean water to the sanitary system. Dispose of asbestos contaminated work clothing as asbestos contaminated waste or properly decontaminate as specified in the ADEM. Keep the floor of the decontamination unit's clean room dry and clean at all times. Proper housekeeping and hygiene requirements must be maintained. Provide soap and towels for showering, washing and drying. Cloth towels provided must be disposed of as ACM waste or must be laundered in accordance with 29 CFR 1926.1101. Physically attach the decontamination units to the asbestos control area. Construct both a personnel decontamination unit and an equipment decontamination unit onto and integral with each asbestos control area.

3.1.3.4 Eye Protection

Provide eye protection that complies with ANSI/ISEA Z87.1 when operations present a potential eye injury hazard. Provide goggles to personnel engaged in asbestos abatement operations when the use of a full face respirator is not required.

3.1.4 Regulated Areas

All Class I, II, and III asbestos work must be conducted within regulated areas. The regulated area must be demarcated to minimize the number of persons within the area and to protect persons outside the area from exposure to airborne asbestos. Control access to regulated areas, ensure that only authorized personnel enter, and verify that Contractor required medical surveillance, training and respiratory protection program requirements are met prior to allowing entrance.

3.1.5 Load-out Unit

Provide a temporary load-out unit that is adjacent and connected to the regulated area. Attach the load-out unit in a leak-tight manner to each regulated area.

3.1.6 Warning Signs and Labels

Provide bilingual warning signs printed in English and **Spanish** at all approaches to asbestos control areas. Locate signs at such a distance that personnel may read the sign and take the necessary protective steps required before entering the area. Provide labels and affix to all asbestos materials, scrap, waste, debris, and other products contaminated with asbestos. Containers with preprinted warning labels conforming to the requirements are acceptable

3.1.6.1 Warning Sign

Provide vertical format conforming to **29 CFR 1926.200**, and **29 CFR 1926.1101** minimum **20 by 14 inches** displaying the following legend in the lower panel:

<u>Legend</u>	<u>Notation</u>
DANGER	one inch Sans Serif Gothic or Block
ASBESTOS	one inch Sans Serif Gothic or Block
MAY CAUSE CANCER	one inch Sans Serif Gothic or Block
CAUSES DAMAGE TO LUNGS	1/4 inch Sans Serif Gothic or Block
AUTHORIZED PERSONNEL ONLY	1/4 inch Sans Serif Gothic or Block
WEAR RESPIRATORY PROTECTION AND PROTECTIVE CLOTHING IN THIS AREA	1/4 inch Sans Serif Gothic or Block

Spacing between lines must be at least equal to the height of the upper of any two lines.

3.1.6.2 Warning Labels

Provide labels conforming to [29 CFR 1926.1101](#) of sufficient size to be clearly legible, displaying the following legend:

DANGER
CONTAINS ASBESTOS FIBERS
MAY CAUSE CANCER
CAUSES DAMAGE TO LUNGS
DO NOT BREATHE DUST AVOID CREATING DUST

3.1.7 Local Exhaust System

Provide a local exhaust system in the asbestos control area in accordance with [ASSP Z9.2](#) and [29 CFR 1926.1101](#) that will provide at least four air changes per hour inside of the negative pressure enclosure. [Local exhaust equipment](#) must be operated 24-hours per day, until the asbestos control area is removed and must be leak proof to the filter and equipped with HEPA filters. Maintain a minimum pressure differential in the control area of minus [0.02 inch](#) of water column relative to adjacent, unsealed areas. Provide continuous 24-hour per day monitoring of the pressure differential with a [pressure differential automatic recording instrument](#). The building ventilation system must not be used as the local exhaust system for the asbestos control area. Filters on exhaust equipment must conform to [ASSP Z9.2](#) and [UL 586](#). Terminate the local exhaust system out of doors and remote from any public access or ventilation system intakes.

3.1.8 Tools

[Vacuums](#) must be leak proof to the filter and equipped with HEPA filters. Filters on vacuums must conform to [ASSP Z9.2](#) and [UL 586](#). Do not use power tools to remove asbestos containing materials unless the tool is equipped with effective, integral HEPA filtered exhaust [ventilation systems](#). Remove all residual asbestos from reusable tools prior to storage or reuse. Reusable tools must be thoroughly decontaminated prior to being removed from the regulated areas.

3.1.9 Rental Equipment

If rental equipment is to be used, furnish written notification to the rental agency concerning the intended use of the equipment and the possibility of asbestos contamination of the equipment.

3.1.10 Glovebags

Submit written manufacturers proof that glovebags will not break down under expected temperatures and conditions.

3.1.11 Single Stage Decontamination Area

A decontamination area (equipment room/area) must be provided for Class I work involving less than [25 feet](#) or [10 square feet](#) of TSI or surfacing ACM, and for Class II and Class III asbestos work operations where

exposures exceed the PELs or where there is no negative exposure assessment. The equipment room or area must be adjacent to the regulated area for the decontamination of employees, material, and their equipment which could be contaminated with asbestos. The area must be covered by an impermeable drop cloth on the floor or horizontal working surface. The area must be of sufficient size to accommodate cleaning of equipment and removing personal protective equipment without spreading contamination beyond the area.

3.1.12 Decontamination Area Exit Procedures

Ensure that the following procedures are followed:

- a. Before leaving the regulated area, remove all gross contamination and debris from work clothing using a HEPA vacuum.
- b. Employees must remove their protective clothing in the equipment room and deposit the clothing in labeled impermeable bags or containers for disposal or laundering.
- c. Employees must not remove their respirators until showering.
- d. Employees must shower prior to entering the clean room. If a shower has not been located between the equipment room and the clean room or the work is performed outdoors, ensure that employees engaged in Class I asbestos jobs: a) Remove asbestos contamination from their work suits in the equipment room or decontamination area using a HEPA vacuum before proceeding to a shower that is not adjacent to the work area; or b) Remove their contaminated work suits in the equipment room, without cleaning worksuits, and proceed to a shower that is not adjacent to the work area.

3.2 WORK PROCEDURE

Once the submittals are approved, the following actions are required.

3.2.1 General

1. Set up the asbestos containment areas, negative air machine, and critical barriers and obtain approval from the APOC to begin work.
2. The APOC routinely checks the abatement work to ensure that the containment area and critical barriers are secure, that the workers are wearing the appropriate personal protective equipment, that the asbestos containing material is being bagged appropriately, and that air monitoring is being conducted on the workers and outside the abatement area (if required). This also includes reviewing the daily log maintained on site to assure that no uncertified individuals are performing abatement work.
3. Upon completion of the abatement work, contact the APOC, to conduct a walk through of the area and approve that all abatement has been completed and that the area has been cleaned of asbestos materials as per the contract scope of work. Provide at least a 24-hour notice period. Reference cleaning procedures in the Asbestos Management and Operations Plan.

3.2.2 Removal of Flooring and Asbestos Mastic

1. Prepare work areas as specified.
2. Mist the flooring with amended water until the flooring surfaces are wet. Do not apply so much water that it spreads or runs. Mop up excess water as necessary.
3. Use hand tools and other mechanical methods to remove the flooring.
4. Remove flooring mastic using mechanical methods and minimum amounts of organic solvents. Use solvent materials and methods that minimize vapors. Provide workers with appropriate respiratory protection for solvent vapors as well as asbestos fibers.
5. Wrap or box removed flooring in cardboard or use other method to prevent sharp edges from puncturing disposal bags/containers.
6. Place removed flooring, mastic, and debris in properly labeled six mil disposal bags and then in another approved container. Ensure that flooring materials do not puncture the outer container.

3.2.3 Work Area Clearance

The work areas are considered ready for re-occupancy when all of the work is completed, the work area is visually clean, and airborne fiber levels have been reduced to the level specified below.

3.2.4 Clearance Testing

1. Perform cleaning of all surfaces in work area and any other immediately adjacent contaminated areas.
2. Upon notice from the Contractor that work areas and all other contaminated and cleaned areas are ready for Clearance Testing, a Base Environmental representative will perform the final visual observations/inspection. For Clearance the work area must be visually clean and the airborne fiber concentration must be equal to or less than 0.01 fibers per cubic centimeter (f/cc). Final Air Clearance testing shall be performed by an independent 3rd party consultant and/or laboratory under the abatement contractor's scope of work.
3. Areas which do not comply with the standard of cleaning shall continue to be cleaned by and at the Contractor's expense until the specified standard of cleaning is achieved as evidenced by visual observations and results of air sampling test results.
4. When the airborne fiber concentration of 0.01 f/cc or less is achieved and observations by Base Environmental determines that the area has been visually decontaminated, the decontamination enclosure system shall be removed, the area thoroughly cleaned and materials from the equipment room and shower disposed of as contaminated waste. The remaining barriers between contaminated and clean areas and all seals on openings into the work area and fixtures shall be removed and disposed of as contaminated waste.

3.2.5 Waste Disposal

Asbestos-containing waste material and debris must be packaged in

accordance with the provisions of this specification and disposed at a properly permitted "Subtitle D" landfill within the State of Alabama.

3.2.5.1 Dispose of asbestos-containing waste as follows:

1. Seal asbestos waste in leak-proof impermeable containers labeled in accordance with OSHA, DOT, and EPA standards.
2. Carefully load containerized waste on enclosed or covered trucks/dumpsters for transport. Exercise care before and during transport to ensure that no unauthorized persons have access to the material.
3. Use only enclosed or covered trucks/dumpsters to haul impermeable containers to prevent loss or damage to container in route to the landfill.
4. Allow only sealed plastic bags or impermeable containers to be deposited in landfill. Leave damaged, leaking, or broken plastic bags in the impermeable container and deposit entire container in landfill.
5. Ensure that there are no visible emissions to the outside air from site where materials and waste are deposited.
6. Contractor may recycle uncontaminated impermeable containers.
7. Retain receipts from landfill for asbestos wastes disposed.
8. Base Environmental must observe the waste prior to leaving the base.

3.2.6 Protection of Existing Work to Remain

Perform work without damage or contamination of adjacent work. Where such work is damaged or contaminated as verified by the Contracting Officer using visual inspection or sample analysis, it must be restored to its original condition or decontaminated by the Contractor at no expense to the Government as deemed appropriate by the Contracting Officer. This includes inadvertent spill of dirt, dust, or debris in which it is reasonable to conclude that asbestos may exist. When these spills occur, stop work immediately. Then clean up the spill. When satisfactory visual inspection and air sampling results are obtained from the APOC work may proceed at the discretion of the Contracting Officer.

3.2.7 Precleaning

Wet wipe and HEPA vacuum all surfaces potentially contaminated with asbestos prior to establishment of an enclosure.

3.2.8 Methods of Compliance

3.2.8.1 Mandated Practices

The specific abatement techniques and items identified must be detailed in the Contractor's AHAP. Use the following engineering controls and work practices in all operations, regardless of the levels of exposure:

- a. Vacuum cleaners equipped with HEPA filters.
- b. Wet methods or wetting agents except where it can be demonstrated that the use of wet methods is unfeasible due to the creation of electrical

hazards, equipment malfunction, and in roofing.

- c. Prompt clean-up and disposal.
- d. Inspection and repair of polyethylene.
- e. Cleaning of equipment and surfaces of containers prior to removing them from the equipment room or area.

3.2.8.2 Control Methods

Use the following control methods:

- a. Local exhaust ventilation equipped with HEPA filter;
- b. Enclosure or isolation of processes producing asbestos dust;
- c. Where the feasible engineering and work practice controls are not sufficient to reduce employee exposure to or below the PELs, use them to reduce employee exposure to the lowest levels attainable and must supplement them by the use of respiratory protection.

3.2.8.3 Unacceptable Practices

The following work practices must not be used:

- a. High-speed abrasive disc saws that are not equipped with point of cut ventilator or enclosures with HEPA filtered exhaust air.
- b. Compressed air used to remove asbestos containing materials, unless the compressed air is used in conjunction with an enclosed ventilation system designed to capture the dust cloud created by the compressed air.
- c. Dry sweeping, shoveling, or other dry clean up.
- d. Employee rotation as a means of reducing employee exposure to asbestos.

3.2.9 Class I Work Procedures

In addition to requirements of paragraphs MANDATED PRACTICES and CONTROL METHODS, the following engineering controls and work practices must be used:

- a. A Competent Person must supervise the installation and operation of the control methods.
- b. For jobs involving the removal of more than 25 feet or 10 square feet of TSI or surfacing material, place critical barriers over all openings to the regulated area.
- c. HVAC systems must be isolated in the regulated area by sealing with a double layer of plastic or air-tight rigid covers.
- d. Impermeable dropcloths (6 mil or greater thickness) must be placed on surfaces beneath all removal activity.
- e. Where a negative exposure assessment has not been provided or where exposure monitoring shows the PEL was exceeded, the regulated area

must be ventilated with a HEPA unit and employees must use PPE.

3.2.10 Class II Work Procedures

In addition to the requirements of paragraphs MANDATED PRACTICES and CONTROL METHODS, the following engineering controls and work practices must be used:

- a. A Competent Person must supervise the work.
- b. For indoor work, critical barriers must be placed over all openings to the regulated area.
- c. Impermeable dropcloths must be placed on surfaces beneath all removal activity.

3.2.11 Specific Control Methods for Class II Work

3.2.11.1 Vinyl and Asphaltic Flooring Materials

Establish designated limits for the asbestos regulated work area with the use of red barrier tape, critical barriers, signs, and maintain all other requirements for asbestos control area except local exhaust. A detached decontamination system may be used. When removing vinyl floor tile and mastic which contains ACM, use the following practices. Remove floor tile and mastic using adequately wet methods. Remove floor tiles intact (if possible). Wetting is not required when floor tiles are heated and removed intact. Do not sand flooring or its backing. Scrape residual adhesive and backing using wet methods. Mechanical chipping is prohibited unless performed in a negative pressure enclosure. Dry sweeping is prohibited. Use vacuums equipped with HEPA filter, disposable dust bag, and metal floor tool (no brush) to clean floors. Place debris into a 6-mil minimum thickness disposal bag or other approved container. Once the material is in the disposal bag, apply additional water as needed to achieve "adequately wet" conditions for NESHAP compliance. Place bagged asbestos waste under negative pressure with the use of a HEPA vacuum, goose neck and duck tape to seal the bag, wash to remove any visible contamination and place into a second 6-mil minimum thickness disposal bag. Containerize asbestos containing waste while wet. Lower and otherwise handle asbestos containing materials as indicated in 40 CFR 61-SUBPART M. Conduct area monitoring of airborne fibers during the work shift at the designated limits of the asbestos work area and conduct personal samples of each worker engaged in the work. If workers the airborne fiber concentration of the workers or designated limits at any time exceeds background or 0.01 fibers per cubic centimeter, whichever is greater, stop work immediately and correct the situation.

3.2.11.2 Sealants and Mastic

Establish designated limits for the asbestos regulated work area with the use of red barrier tape, critical barriers and signs, and maintain all other requirements for asbestos control area except local exhaust. Spread 6-mil plastic sheeting on the ground around the perimeter of the work area extending out in all directions. Using adequately wet methods, carefully remove the ACM sealants and mastics using a scraper of knife blade. As it is removed place the material into a disposal bag. Make every effort to keep the asbestos material from falling to the ground or work area floor below. Dry sweeping is prohibited. Use vacuums equipped with HEPA filter and disposable dust bag. Place debris into a 6-mil minimum thickness

disposal bag or other approved container. Once the material is in the disposal bag, apply additional water as needed to achieve "adequately wet" conditions for NESHAP compliance. Place bagged asbestos waste under negative pressure with the use of a HEPA vacuum, goose neck and duck tape to seal the bag, wash to remove any visible contamination and place into a second 6-mil minimum thickness disposal bag. Containerize asbestos containing waste while wet. Lower and otherwise handle asbestos containing materials as indicated in 40 CFR 61-SUBPART M. Conduct area monitoring of airborne fibers during the work shift at the designated limits of the asbestos work area and conduct personal samples of each worker engaged in the work. If the airborne fiber concentration of the workers or at designated limits at any time exceeds background or 0.01 fibers per cubic centimeter, whichever is greater, stop work immediately and correct the situation.

3.2.11.3 Roofing Materials

Establish designated limits for the asbestos regulated work area with the use of red barrier tape, critical barriers, signs, and maintain all other requirements for asbestos control area except local exhaust. When removing roofing materials which contain ACM as described in 29 CFR 1926.1101(g)(8)(ii), use the following practices. Roofing material must be removed in an intact state. Wet methods must be used to remove roofing materials that are not intact, or that will be rendered not intact during removal, unless such wet methods are not feasible or will create safety hazards. When removing built-up roofs, with asbestos-containing roofing felts and an aggregate surface, using a power roof cutter, all dust resulting from the cutting operations must be collected by a HEPA dust collector, or must be HEPA vacuumed by vacuuming along the cut line. Asbestos-containing roofing material must not be dropped or thrown to the ground, but must be lowered to the ground via covered, dust-tight chute, crane, hoist or other method approved by the Contracting Officer. Any ACM that is not intact must be lowered to the ground as soon as practicable, but not later than the end of the work shift. While the material remains on the roof it must be kept wet or placed in an impermeable waste bag or wrapped in plastic sheeting. Intact ACM must be lowered to the ground as soon as practicable, but not later than the end of the work shift. Unwrapped material must be transferred to a closed receptacle. Critical barriers must be placed over roof level heating and ventilation air intakes. Conduct area monitoring of airborne fibers during the work shift at the designated limits of the asbestos work area and conduct personal samples of each worker engaged in the work. If the airborne fiber concentration of the workers or designated limits at any time exceeds background or 0.01 fibers per cubic centimeter, whichever is greater, stop work immediately and correct the situation.

3.2.11.4 Gaskets

Establish designated limits for the asbestos regulated work area with the use of red barrier tape, critical barriers, signs, and maintain all other requirements for asbestos control area except local exhaust. Gaskets must be thoroughly wetted with amended water prior to removal and immediately placed in a disposal container. If a gasket is visibly deteriorated and unlikely to be removed intact, removal must be undertaken within a glovebag. Any scraping to remove residue must be performed wet. Place debris into a 6-mil minimum thickness disposal bag or other approved container. Once the material is in the disposal bag, apply additional water as needed to achieve "adequately wet" conditions for NESHAP compliance. Place bagged asbestos waste under negative pressure with the

use of a HEPA vacuum, goose neck and duck tape to seal the bag, wash to remove any visible contamination and place into a second 6-mil minimum thickness disposal bag. Containerize asbestos containing waste while wet. Conduct area monitoring of airborne fibers during the work shift at the designated limits of the asbestos work area and conduct personal samples of each worker engaged in the work. If the airborne fiber concentration of the workers or designated limits at any time exceeds background or 0.01 fibers per cubic centimeter, whichever is greater, stop work immediately and correct the situation.

3.2.12 Abatement of Asbestos Contaminated Soil

Establish designated limits for the asbestos regulated work area with the use of red barrier tape, critical barriers, signs, and maintain all other requirements for asbestos control area except local exhaust. Asbestos contaminated soil must be removed from areas to a minimum depth of 2 inches. Soil must be thoroughly dampened with amended water and then removed by manual shoveling into labeled containers. Place debris into a 6-mil minimum thickness disposal bag or other approved container. Once the material is in the disposal bag, apply additional water as needed to achieve "adequately wet" conditions for NESHAP compliance. Place bagged asbestos waste under negative pressure with the use of a HEPA vacuum, goose neck and duck tape to seal the bag, wash to remove any visible contamination and place into a second 6-mil minimum thickness disposal bag. Containerize asbestos containing waste while wet. Conduct area monitoring of airborne fibers during the work shift at the designated limits of the asbestos work area and conduct personal samples of each worker engaged in the work. If the airborne fiber concentration of the workers or designated limits at any time exceeds background or 0.01 fibers per cubic centimeter, whichever is greater, stop work immediately and correct the situation.

3.2.13 Air Sampling

Perform sampling of airborne concentrations of asbestos fibers in accordance with 29 CFR 1926.1101, the Contractor's air monitoring plan and as specified herein. Sampling performed in accordance with 29 CFR 1926.1101 must be performed by the PQP. Sampling performed for environmental and quality control reasons must be performed by the APOC. Unless otherwise specified, use NIOSH Method 7400 for sampling and analysis. Monitoring may be duplicated by the Government at the discretion of the Contracting Officer. If the air sampling results obtained by the Government differ from those results obtained by the Contractor, the Government will determine which results predominate. Results of breathing zone samples must be posted at the job site and made available to the Contracting Officer. Submit all documentation regarding initial exposure assessments, negative exposure assessments, and air-monitoring results.

3.2.13.1 Sampling Prior to Asbestos Work

Provide area air sampling and establish the baseline one day prior to the masking and sealing operations for each removal site. Establish the background by performing area sampling in similar but uncontaminated sites in the building.

3.2.13.2 Sampling During Asbestos Work

The PQP must provide personal sampling as indicated in 29 CFR 1926.1101.

Breathing zone samples must be taken for at least 25 percent of the workers in each shift, or a minimum of two, whichever is greater. Breathing zone samples must be taken for at least 25 percent of the workers in each shift, or a minimum of two, whichever is greater. Air sample fiber counting must be completed and results provided within 24-hours (breathing zone samples), and 24 hours (environmental/clearance monitoring) after completion of a sampling period. At the same time the GC will provide area sampling close to the work inside the enclosure, outside the clean room entrance to the enclosure, and at the exhaust opening of the local exhaust system. In addition, provided the same type of work is being performed, the GC will provide area sampling once every work shift close to the work inside the enclosure, outside the clean room entrance to the enclosure, and at the exhaust opening of the local exhaust system. If sampling outside the enclosure shows airborne levels have exceeded background or 0.01 fibers per cubic centimeter, whichever is greater, stop all work, correct the condition(s) causing the increase, and notify the Contracting Officer immediately. Where alternate methods are used, perform personal and area air sampling at locations and frequencies that will accurately characterize the evolving airborne asbestos levels. The written results must be signed by testing laboratory analyst, testing laboratory principal and the APOC. The air sampling results must be documented on a Contractor's daily air monitoring log.

3.2.13.3 Final Clearance Requirements, NIOSH PCM Method

After the abatement has been completed, and approved by Base Environmental, submit the following items in a post-job submittal to be maintained in the Asbestos Abatement Files.

- a. Air sampling analytical results
- b. Daily report log
- c. Daily worker sign-in/out sheets
- d. Waste manifest
- e. Copies of the Safe State Certificates, documentation of respiratory protection training and fit testing, and signed Worker Acknowledgment forms for any workers or supervisors that worked on the project but whose documentation was not included with the pre-job submittals.

For PCM sampling and analysis using NIOSH NMAM Method 7400, the fiber concentration inside the abated regulated area, for each airborne sample, must be less than 0.01 f/cc. The abatement inside the regulated area is considered complete when every PCM final clearance sample is below the clearance limit. If any sample result is greater than 0.01 total f/cc, the asbestos fiber concentration (asbestos f/cc) must be confirmed from that same filter using NIOSH NMAM Method 7402 (TEM) at Contractor's expense. If any confirmation sample result is greater than 0.01 asbestos f/cc, abatement is incomplete and cleaning must be repeated at the Contractor's expense. Upon completion of any required recleaning, resampling with results to meet the above clearance criteria must be done at the Contractor's expense.

3.2.13.4 Sampling After Final Clean-Up (Clearance Sampling)

Provide area sampling of asbestos fibers and establish an airborne

asbestos concentration of less than 0.01 fibers per cubic centimeter after final clean-up but before removal of the enclosure or the asbestos work control area. After final cleanup and the asbestos control area is dry but prior to clearance sampling, the APOC must perform a visual inspection in accordance with ASTM E1368 to ensure that the asbestos control and work area is free of any accumulations of dirt, dust, or debris. The asbestos fiber counts from these samples must be less than 0.01 fibers per cubic centimeter or be not greater than the background, whichever is greater. Should any of the final samples indicate a higher value take appropriate actions to re-clean the area and repeat the sampling and analysis at the Contractor's expense.

3.2.13.5 Air Clearance Failure

If clearance sampling results fail to meet the final clearance requirements, pay all costs associated with the required recleaning, resampling, and analysis, until final clearance requirements are met.

3.2.14 Lock-Down

Prior to removal of plastic barriers and after pre-clearance clean up of gross contamination, the APOC must conduct a visual inspection of all areas affected by the removal in accordance with ASTM E1368. Inspect for any visible fibers. Spray apply a post removal (lock-down) encapsulant to ceiling, walls, floors and other areas exposed in the removal area. The exposed area includes but is not limited to plastic barriers, furnishings and articles to be discarded as well as dirty change room, air locks for bag removal and decontamination chambers.

3.2.15 Site Inspection

While performing asbestos engineering control work, the Contractor must be subject to on-site inspection by the Contracting Officer and the APOC who may be assisted by or represented by safety or industrial hygiene personnel. If the work is found to be in violation of this specification, the Contracting Officer or his representative will issue a stop work order to be in effect immediately and until the violation is resolved. All related costs including standby time required to resolve the violation must be at the Contractor's expense.

3.3 CLEAN-UP AND DISPOSAL

3.3.1 Housekeeping

Essential parts of asbestos dust control are housekeeping and clean-up procedures. Maintain surfaces of the asbestos control area free of accumulations of asbestos fibers. Give meticulous attention to restricting the spread of dust and debris; keep waste from being distributed over the general area. Use HEPA filtered vacuum cleaners. DO NOT BLOW DOWN THE SPACE WITH COMPRESSED AIR. When asbestos removal is complete, all asbestos waste is removed from the work-site, and final clean-up is completed, the Contracting Officer will attest that the area is safe before the signs can be removed. After final clean-up and acceptable airborne concentrations are attained but before the HEPA unit is turned off and the enclosure removed, remove all pre-filters on the building HVAC system and provide new pre-filters. Dispose of filters as asbestos contaminated materials. Reestablish HVAC mechanical, and electrical systems in proper working order. The Contracting Officer will visually inspect all surfaces within the enclosure for residual material

or accumulated dust or debris. The Contractor must re-clean all areas showing dust or residual materials. If re-cleaning is required, air sample and establish an acceptable asbestos airborne concentration after re-cleaning. The Contracting Officer must agree that the area is safe in writing before unrestricted entry will be permitted. The Government must have the option to perform monitoring to determine if the areas are safe before entry is permitted.

3.3.2 Title to Materials

All waste materials, except as specified otherwise, become the property of the Contractor and must be disposed of as specified in applicable local, State, and Federal regulations and herein.

3.3.3 Disposal of Asbestos

3.3.3.1 Procedure for Disposal

Coordinate all waste disposal manifests with the Contracting Officer and APOC. Collect asbestos waste, contaminated waste water filters, asbestos contaminated water, scrap, debris, bags, containers, equipment, and asbestos contaminated clothing which may produce airborne concentrations of asbestos fibers and place in sealed fiber-proof, waterproof, non-returnable containers (e.g. double plastic bags 6 mils thick, cartons, drums or cans). Wastes within the containers must be adequately wet in accordance with 40 CFR 61-SUBPART M. Affix a warning and Department of Transportation (DOT) label to each container including the bags or use at least 6 mils thick bags with the approved warnings and DOT labeling preprinted on the bag. Clearly indicate on the outside of each container the name of the waste generator and the location at which the waste was generated. Prevent contamination of the transport vehicle (especially if the transport vehicle is a rented truck likely to be used in the future for non-asbestos purposes). These precautions include lining the vehicle cargo area with plastic sheeting (similar to work area enclosure) and thorough cleaning of the cargo area after transport and unloading of asbestos debris is complete. Dispose of waste asbestos material at an Environmental Protection Agency (EPA) or State-approved asbestos landfill off Government property. For temporary storage, store sealed impermeable bags in asbestos waste drums or skids. An area for interim storage of asbestos waste-containing drums or skids will be assigned by the Contracting Officer or his authorized representative. Comply with 40 CFR 61-SUBPART M, State, regional, and local standards for hauling and disposal. Sealed plastic bags may be dumped from drums into the burial site unless the bags have been broken or damaged. Damaged bags must remain in the drum and the entire contaminated drum must be buried. Uncontaminated drums may be recycled. Workers unloading the sealed drums must wear appropriate respirators and personal protective equipment when handling asbestos materials at the disposal site.

3.3.3.2 Asbestos Disposal Quantity Report

Allow the GC to inspect, record and report the amount of asbestos containing material removed and released for disposal on a daily basis.

-- End of Section --

SECTION 03 30 00

CAST-IN-PLACE CONCRETE
02/19, CHG 4: 08/22

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 117	(2010; Errata 2011) Specifications for Tolerances for Concrete Construction and Materials and Commentary
ACI 121R	(2008) Guide for Concrete Construction Quality Systems in Conformance with ISO 9001
ACI 301	(2016) Specifications for Structural Concrete
ACI 302.1R	(2015) Guide for Concrete Floor and Slab Construction
ACI 304.2R	(2017) Guide to Placing Concrete by Pumping Methods
ACI 304R	(2000; R 2009) Guide for Measuring, Mixing, Transporting, and Placing Concrete
ACI 305.1	(2014) Specification for Hot Weather Concreting
ACI 305R	(2020) Guide to Hot Weather Concreting
ACI 306.1	(1990; R 2002) Standard Specification for Cold Weather Concreting
ACI 308.1	(2011) Specification for Curing Concrete
ACI SP-2	(2007; Abstract: 10th Edition) ACI Manual of Concrete Inspection
ACI SP-15	(2011) Field Reference Manual: Standard Specifications for Structural Concrete ACI 301-05 with Selected ACI References

AMERICAN HARDBOARD ASSOCIATION (AHA)

AHA A135.4	(1995; R 2004) Basic Hardboard

AMERICAN WELDING SOCIETY (AWS)

AWS D1.4/D1.4M (2011) Structural Welding Code -
Reinforcing Steel

ASTM INTERNATIONAL (ASTM)

ASTM A53/A53M (2022) Standard Specification for Pipe,
Steel, Black and Hot-Dipped, Zinc-Coated,
Welded and Seamless

ASTM A615/A615M (2022) Standard Specification for Deformed
and Plain Carbon-Steel Bars for Concrete
Reinforcement

ASTM A706/A706M (2022) Standard Specification for
Low-Alloy Steel Deformed and Plain Bars
for Concrete Reinforcement

ASTM A934/A934M (2022) Standard Specification for
Epoxy-Coated Prefabricated Steel
Reinforcing Bars

ASTM C31/C31M (2022) Standard Practice for Making and
Curing Concrete Test Specimens in the Field

ASTM C39/C39M (2021) Standard Test Method for
Compressive Strength of Cylindrical
Concrete Specimens

ASTM C42/C42M (2020) Standard Test Method for Obtaining
and Testing Drilled Cores and Sawed Beams
of Concrete

ASTM C78/C78M (2022) Standard Test Method for Flexural
Strength of Concrete (Using Simple Beam
with Third-Point Loading)

ASTM C94/C94M (2022a) Standard Specification for
Ready-Mixed Concrete

ASTM C143/C143M (2020) Standard Test Method for Slump of
Hydraulic-Cement Concrete

ASTM C150/C150M (2022) Standard Specification for Portland
Cement

ASTM C172/C172M (2017) Standard Practice for Sampling
Freshly Mixed Concrete

ASTM C173/C173M (2016) Standard Test Method for Air
Content of Freshly Mixed Concrete by the
Volumetric Method

ASTM C231/C231M (2022) Standard Test Method for Air
Content of Freshly Mixed Concrete by the
Pressure Method

ASTM C260/C260M (2010a; R 2016) Standard Specification for

Air-Entraining Admixtures for Concrete

ASTM C309	(2019) Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C618	(2022) Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C803/C803M	(2018) Standard Test Method for Penetration Resistance of Hardened Concrete
ASTM C873/C873M	(2015) Standard Test Method for Compressive Strength of Concrete Cylinders Cast in Place in Cylindrical Molds
ASTM C900	(2015) Standard Test Method for Pullout Strength of Hardened Concrete
ASTM C989/C989M	(2022) Standard Specification for Slag Cement for Use in Concrete and Mortars
ASTM C1074	(2019) Standard Practice for Estimating Concrete Strength by the Maturity Method
ASTM C1077	(2017) Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation
ASTM C1107/C1107M	(2020) Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
ASTM C1260	(2021) Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
ASTM C1602/C1602M	(2022) Standard Specification for Mixing Water Used in Production of Hydraulic Cement Concrete
ASTM D1751	(2018) Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
ASTM E96/E96M	(2022a) Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials
ASTM E329	(2021) Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection
ASTM E1643	(2018a) Standard Practice for Selection, Design, Installation, and Inspection of Water Vapor Retarders Used in Contact with

Earth or Granular Fill Under Concrete Slabs

ASTM E1745

(2017) Standard Specification for Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs

CONCRETE REINFORCING STEEL INSTITUTE (CRSI)

CRSI 10MSP

(2018) Manual of Standard Practice

CRSI RB4.1

(2016) Supports for Reinforcement Used in Concrete

FOREST STEWARDSHIP COUNCIL (FSC)

FSC STD 01 001

(2015) Principles and Criteria for Forest Stewardship

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

NIST PS 1

(2009) DOC Voluntary Product Standard PS 1-07, Structural Plywood

U.S. GREEN BUILDING COUNCIL (USGBC)

LEED NC

(2013) Leadership in Energy and Environmental Design(tm) New Construction Rating System

1.2 DEFINITIONS

- a. "Cementitious material" as used herein must include all portland cement, pozzolan, fly ash, slag cement, and silica fume.
- b. "Exposed to public view" means situated so that it can be seen from eye level from a public location after completion of the building. A public location is accessible to persons not responsible for operation or maintenance of the building.
- c. "Chemical admixtures" are materials in the form of powder or fluids that are added to the concrete to give it certain characteristics not obtainable with plain concrete mixes.
- d. "Supplementary cementing materials" (SCM) include coal fly ash, silica fume, slag cement, natural or calcined pozzolans, and ultra-fine coal ash when used in such proportions to replace the portland cement that result in improvement to sustainability and durability and reduced cost.
- e. "Design strength" (f'c) is the specified compressive strength of concrete at time(s) specified in this section to meet structural design criteria.
- f. "Mass Concrete" is any concrete system that approaches a maximum temperature of 158 degrees F within the first 72 hours of placement. In addition, it includes all concrete elements with a section thickness of 3 feet or more regardless of temperature.
- g. "Mixture proportioning" is the process of designing concrete mixture

proportions to enable it to meet the strength, service life and constructability requirements of the project while minimizing the initial and life-cycle cost.

- h. "Mixture proportions" are the masses or volumes of individual ingredients used to make a unit measure (cubic meter or cubic yard) of concrete.
- i. "Pozzolan" is a siliceous or siliceous and aluminous material, which in itself possesses little or no cementitious value but will, in finely divided form and in the presence of moisture, chemically react with calcium hydroxide at ordinary temperatures to form compounds possessing cementitious properties.
- j. "Workability (or consistence)" is the ability of a fresh (plastic) concrete mix to fill the form/mould properly with the desired work (vibration) and without reducing the concrete's quality. Workability depends on water content, chemical admixtures, aggregate (shape and size distribution), cementitious content and age (level of hydration).

1.3 SUBMITTALS

Government approval is required for submittals. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Concrete Curing Plan

Quality Control Plan

Quality Control Personnel Certifications

Quality Control Organizational Chart

Laboratory Accreditation

Form Removal Schedule

Maturity Method Data

SD-02 Shop Drawings

Formwork

Reinforcing Steel

SD-03 Product Data

Joint Filler

Formwork Materials

Cementitious Materials; (LEED NC)

Vapor Barrier

Concrete Curing Materials

Reinforcement

Liquid Chemical Floor Hardeners and Sealers

Admixtures

Local/Regional Materials

Biodegradable Form Release Agent

Pumping Concrete

Finishing Plan

Nonshrink Grout

SD-04 Samples

SD-05 Design Data

Concrete Mix Design

SD-06 Test Reports

Concrete Mix Design

Slag Cement

Compressive Strength Tests;

Air Content

Slump Tests

Water

SD-07 Certificates

Reinforcing Bars

Welder Qualifications

VOC Content for Form Release Agents, Curing Compounds, and
Concrete Penetrating Sealers

Safety Data Sheets

Forest Stewardship Council (FSC) Certification

Field Testing Technician and Testing Agency

SD-08 Manufacturer's Instructions

Liquid Chemical Floor Hardeners and Sealers

Curing Compound

1.4 MODIFICATION OF REFERENCES

Accomplish work in accordance with ACI publications except as modified herein. Consider the advisory or recommended provisions to be mandatory. Interpret reference to the "Building Official," the "Structural Engineer," and the "Architect/Engineer" to mean the Contracting Officer.

1.5 DELIVERY, STORAGE, AND HANDLING

Follow [ACI 301](#), [ACI 304R](#) and [ASTM A934/A934M](#) requirements and recommendations. Do not deliver concrete until vapor barrier, forms, reinforcement, embedded items, and chamfer strips are in place and ready for concrete placement. Do not store concrete curing compounds or sealers with materials that have a high capacity to adsorb volatile organic compound (VOC) emissions. Do not store concrete curing compounds or sealers in occupied spaces.

1.5.1 Reinforcement

Store reinforcement of different sizes and shapes in separate piles or racks raised above the ground to avoid excessive rusting. Protect from contaminants such as grease, oil, and dirt. Ensure bar sizes can be accurately identified after bundles are broken and tags removed.

1.6 QUALITY ASSURANCE

1.6.1 Design Data

1.6.1.1 Concrete Mix Design

Sixty days minimum prior to concrete placement, submit a mix design for each strength and type of concrete. Submit a complete list of materials including type; brand; source and amount of cement, supplementary cementitious materials, and admixtures; and applicable reference specifications. Submit mill test and all other test for cement, supplementary cementitious materials, aggregates, and admixtures. Provide documentation of maximum nominal aggregate size, gradation analysis, percentage retained and passing sieve, and a graph of percentage retained verses sieve size. Provide mix proportion data using at least three different water-cementitious material ratios for each type of mixture, which produce a range of strength encompassing those required for each type of concrete required. If source material changes, resubmit mix proportion data using revised source material. Provide only materials that have been proven by trial mix studies to meet the requirements of this specification, unless otherwise approved in writing by the Contracting Officer. Indicate clearly in the submittal where each mix design is used when more than one mix design is submitted. Resubmit data on concrete components if the qualities or source of components changes. Required average strength can be documented by field experience if field strength test data are available and represent a single group of at least 10 consecutive strength tests for one mixture, using materials and conditions similar to those expected for work, and encompassing a period of not less than 45 days. The average of field strength tests shall equal or exceed fcr'. Changes in materials, conditions, and proportions within the test record shall not have been more closely restricted than those for the proposed work. Test records shall not be more than 24 months old. Obtain mix design approval from the contracting officer prior to concrete placement.

1.6.2 Shop Drawings

1.6.2.1 Formwork

Drawings showing details of formwork including, but not limited to; joints, supports, studding and shoring, and sequence of form and shoring removal. Indicate placement schedule, construction, location and method of forming control joints. Include locations of inserts, conduit, sleeves and other embedded items. Reproductions of contract drawings are unacceptable. Submit **form removal schedule** indicating element and minimum length of time for form removal.

Design, fabricate, erect, support, brace, and maintain formwork so that it is able to support, without failure, all vertical and lateral loads that may reasonably be anticipated to be applied to the formwork.

1.6.2.2 Reinforcing Steel

Indicate bending diagrams, assembly diagrams, splicing and laps of bars, shapes, dimensions, and details of bar reinforcing, accessories, and concrete cover. Do not scale dimensions from structural drawings to determine lengths of reinforcing bars. Reproductions of contract drawings are unacceptable.

1.6.3 Control Submittals

1.6.3.1 Concrete Curing Plan

Submit proposed materials, methods and duration for curing concrete elements in accordance with **ACI 308.1**.

1.6.3.2 Pumping Concrete

Submit proposed materials and methods for pumping concrete. Submittal must include mix designs, pumping equipment including type of pump and size and material for pipe, and maximum length and height concrete is to be pumped.

1.6.3.3 Finishing Plan

Submit proposed material and procedures to be used in obtaining the finish for the floors **indicated**. Include qualification of person to be used for obtaining floor tolerance measurement, description of measuring equipment to be used, and a sketch showing lines and locations the measuring equipment will follow.

1.6.3.4 VOC Content for form release agents, curing compounds, and concrete penetrating sealers

Submit certification for the form release agent, curing compounds, and concrete penetrating sealers that indicate the VOC content of each product.

1.6.3.5 Safety Data Sheets

Submit Safety Data Sheets (SDS) for all materials that are regulated for hazardous health effects. SDS must be readily accessible during each work shift to employees when they are at the construction site.

1.6.4 Test Reports

1.6.4.1 Slag Cement

Submit test results in accordance with **ASTM C989/C989M** for slag cement. Submit test results performed within 6 months of submittal date.

1.6.5 Field Samples

1.6.6 Quality Control Plan

Develop and submit for approval a concrete quality control program in accordance with the guidelines of **ACI 121R** and as specified herein. The plan must include approved laboratories. Provide direct oversight for the concrete qualification program inclusive of associated sampling and testing. All quality control reports must be provided to the Contracting Officer, Quality Manager and Concrete Supplier. Maintain a copy of **ACI SP-15** and **CRSI 10MSP** at project site.

1.6.7 Quality Control Personnel Certifications

The Contractor must submit for approval the responsibilities of the various quality control personnel, including the names and qualifications of the individuals in those positions and a **quality control organizational chart** defining the quality control hierarchy and the responsibility of the various positions. Quality control personnel must be employed by the Contractor.

Submit American Concrete Institute certification for the following:

- a. CQC personnel responsible for inspection of concrete operations.
- b. Lead Foreman or Journeyman of the Concrete Placing, Finishing, and Curing Crews.
- c. Field Testing Technicians: ACI Concrete Field Testing Technician, Grade I.

1.6.7.1 Quality Manager Qualifications

The quality manager must hold a current license as a professional engineer in a U.S. state or territory with experience on at least five similar projects. Evidence of extraordinary proven experience may be considered by the Contracting Officer as sufficient to act as the Quality Manager.

1.6.7.2 Field Testing Technician and Testing Agency

Submit data on qualifications of proposed testing agency and technicians for approval by the Contracting Officer prior to performing testing on concrete.

- a. Work on concrete under this contract must be performed by an ACI Concrete Field Testing Technician Grade 1 qualified in accordance with **ACI SP-2** or equivalent. Equivalent certification programs must include requirements for written and performance examinations as stipulated in **ACI SP-2**.
- b. Laboratory personnel will attend the pre-pour conference and verify the training and equipment afforded the contractor's personnel. They

may also visit the batching plant to observe the operation and sample aggregates being employed. Failure to plant or materials to meet specification requirements will disqualify the concrete supplier

- c. Testing agencies that perform testing services on reinforcing steel must meet the requirements of ASTM E329.
- d. Testing agencies that perform testing services on concrete materials must meet the requirements of ASTM C1077.

1.6.8 Laboratory Qualifications for Concrete Qualification Testing

The concrete testing laboratory must have the necessary equipment and experience to accomplish required testing. The laboratory must meet the requirements of ASTM C1077 and be Cement and Concrete Reference Laboratory (CCRL) inspected.

1.7 LABORATORY ACCREDITATION

Laboratory and testing facilities must be provided by and at the expense of the Contractor. The laboratories performing the tests must be accredited in accordance with ASTM C1077, including ASTM C78/C78M and ASTM C1260. The accreditation must be current and must include the required test methods, as specified. Furthermore, the testing must comply with the following requirements:

- a. Aggregate Testing and Mix Proportioning: Aggregate testing and mixture proportioning studies must be performed by an accredited laboratory and under the direction of a registered professional engineer in a U.S. state or territory competent in concrete materials who is competent in concrete materials and must sign all reports and designs.
- b. Acceptance Testing: Furnish all materials, labor, and facilities required for molding, curing, testing, and protecting test specimens at the site and in the laboratory. Furnish and maintain boxes or other facilities suitable for storing and curing the specimens at the site while in the mold within the temperature range stipulated by ASTM C31/C31M.
- c. Reports will be submitted to the Contracting Officer within 3 days of each test, with copies sent to the Contractor for his convenience. Reports will indicate test results, exact location where mix was placed, date and time of placement, air temperature, specified properties of the mix and trip ticket verification.

1.7.1 Contractor Quality Control

All sampling and testing must be performed by an approved, onsite, independent, accredited laboratory. The Contractor shall coordinate his work with that of the test lab, by giving advance notice to the lab when operations which require lab services are about to commence. The Contractor shall conduct his work so that the minimum practical number of trips by lab personnel will be required.

1.8 ENVIRONMENTAL REQUIREMENTS

Provide space ventilation according to material manufacturer recommendations, at a minimum, during and following installation of concrete curing compound and sealer. Maintain one of the following

ventilation conditions during the curing period or for 72 hours after installation:

- a. Supply 100 percent outside air 24 hours a day.
- b. Supply airflow at a rate of 6 air changes per hour, when outside temperatures are between 55 degrees F and 84 degrees F and humidity is between 30 percent and 60 percent.
- c. Supply airflow at a rate of 1.5 air changes per hour, when outside air conditions are not within the range stipulated above.

1.8.1 Submittals for Environmental Performance

- a. Provide data indication the percentage of post-industrial pozzolan (slag cement) cement substitution as a percentage of the full product composite by weight.
- b. Provide data indicating the percentage of post-industrial and post-consumer recycled content aggregate.
- c. Provide product data indicating the percentage of post-consumer recycled steel content in each type of steel reinforcement as a percentage of the full product composite by weight.
- d. Provide product data stating the location where all products were manufactured
- e. For projects using FSC certified formwork, provide chain-of-custody documentation for all certified wood products.
- f. For projects using reusable formwork, provide data showing how formwork is reused.
- g. Provide SDS product information data showing that form release agents meet any environmental performance goals such as using vegetable and soy based products.
- h. Provide SDS product information data showing that concrete adhesives meet any environmental performance goals including low emitting, low volatile organic compound products.

1.9 SUSTAINABLE DESIGN REQUIREMENTS

1.9.1 Local/Regional Materials

Use materials or products extracted, harvested, or recovered, as well as manufactured, within a 500 mile radius from the project site, if available from a minimum of three sources.

1.9.2 Forest Stewardship Council (FSC) Certification

Use FSC-certified wood where specified. Provide letter of certification signed by lumber supplier. Indicate compliance with FSC STD 01 001 and identify certifying organization. Submit FSC certification numbers; identify each certified product on a line-item basis. Submit copies of invoices bearing the FSC certification numbers.

1.10 QUALIFICATIONS FOR WELDING WORK

Welding procedures must be in accordance with AWS D1.4/D1.4M.

Verify that welder qualifications are in accordance with AWS D1.4/D1.4M for welding of reinforcement or under an equivalent qualification test approved in advance. Welders are permitted to do only the type of welding for which each is specifically qualified.

PART 2 PRODUCTS

2.1 FORMWORK MATERIALS

- a. Form-facing material in contact with concrete must be plywood for rough surface, or tempered concrete-form-grade hardboard for smooth or rubbed surface finish,. Submit product information on proposed form-facing materials if different from that specified herein.
- b. Design formwork, shores, reshores, and backshores to support loads transmitted to them and to comply with applicable building code requirements.
- c. Design formwork and shoring for load redistribution resulting from stressing of post-tensioned reinforcement. Ensure that formwork allows movement resulting from application of prestressing force.
- d. Design formwork to withstand pressure resulting from placement and vibration of concrete and to maintain specified tolerances.
- e. Design formwork to accommodate waterstop materials in joints at locations indicated in Contract Documents.
- f. Provide temporary openings in formwork if needed to facilitate cleaning and inspection.
- g. Design formwork joints to inhibit leakage of mortar.
- h. Limit deflection of facing materials for concrete surfaces exposed to view to 1/240 of center-to-center spacing of facing supports.
- i. Do not use earth cuts as forms for vertical or sloping surfaces.
- j. Submit procedure for reshoring and backshoring, including drawings signed and sealed by a licensed design engineer. Include on shop drawings the formwork removal procedure and magnitude of construction loads used for design of reshoring or backshoring system. Indicate in procedure the magnitude of live and dead loads assumed for required capacity of the structure at time of reshoring or backshoring.

2.1.1 Wood Forms

Use lumber as specified in Section 06 10 00 ROUGH CARPENTRY and as follows. Provide lumber that is square edged or tongue-and-groove boards, free of raised grain, knotholes, or other surface defects. Provide plywood that complies with NIST PS 1, B-B concrete form panels or better or AHA A135.4, hardboard for smooth form lining.

2.1.1.1 Concrete Form Plywood (Standard Rough)

Provide plywood that conforms to **NIST PS 1**, B-B, concrete form, not less than **5/8-inch** thick.

2.1.1.2 Overlaid Concrete Form Plywood (Standard Smooth)

Provide plywood that conforms to **NIST PS 1**, B-B, high density form overlay, not less than **5/8-inch** thick.

2.1.2 Corrugated Centering

Provide for pipe trench forming; Roll-Form "Permaform" Type S, 28 gauge galvanized sheets. Lap sides 2 corrugations with edges up. Lay on tunnel walls with min. 2 inch bearing. No fastening required. Shore up to prevent sagging until concrete has cured sufficiently.

2.2 FORMWORK ACCESSORIES

- a. Use commercially manufactured formwork accessories, including ties and hangers.
- b. Form ties and accessories must not reduce the effective cover of the reinforcement.

2.2.1 Form Ties

- a. Use form ties with ends or end fasteners that can be removed without damage to concrete.
- b. Where indicated in Contract Documents, use form ties with integral water barrier plates or other acceptable positive water barriers in walls.
- c. The breakback distance for ferrous ties must be at least **1 in.** for Surface Finish-2.0 or Surface Finish-3.0, as defined in **ACI 301**.
- e. Submit manufacturer's data sheet on form ties.

2.2.2 Biodegradable Form Release Agent

- a. Provide form release agent that is colorless, biodegradable, and **non-staining form oil or lacquer**, with a low (maximum of 55 grams/liter (g/l)) VOC content.
- b. Provide product that does not bond with, stain, or adversely affect concrete surfaces and does not impair subsequent treatments of concrete surfaces.
- c. Provide form release agent that reduces formwork moisture absorption, and does not contain diesel fuel, petroleum-based lubricating oils, waxes, or kerosene. Submit documentation indicating type of biobased material in product and biobased content. Indicate relative dollar value of biobased content products to total dollar value of products included in project.
- d. Submit manufacturer's product data on formwork release agent for use on each form-facing material.

2.2.3 Chamfer Materials

Use lumber materials with dimensions of $3/4 \times 3/4$ in.

2.2.4 Construction and movement joints

- a. Submit details and locations of construction joints in accordance with the requirements herein.
- b. Locate construction joints within middle one-third of spans of slabs, beams, and girders. If a beam intersects a girder within the middle one-third of girder span, the distance between the construction joint in the girder and the edge of the beam must be at least twice the width of the larger member.
- c. For members with post-tensioning tendons, locate construction joints where tendons pass through centroid of concrete section.
- d. Locate construction joints in walls and columns at underside of slabs, beams, or girders and at tops of footings or slabs.
- e. Make construction joints perpendicular to main reinforcement.
- f. Provide movement joints where indicated in Contract Documents or in accepted alternate locations.
- g. Submit location and detail of movement joints if different from those indicated in Contract Documents.
- h. Submit manufacturer's data sheet on expansion joint materials.
- i. Provide keyways where indicated in Contract Documents.

2.2.5 Other Embedded items

Use sleeves, inserts, anchors, and other embedded items of material and design indicated in Contract Documents.

2.3 CONCRETE MATERIALS

2.3.1 Cementitious Materials

2.3.1.1 Portland Cement

- a. Unless otherwise specified, provide cement that conforms to **ASTM C150/C150M** Type I.
- b. Use one brand and type of cement for formed concrete having exposed-to-view finished surfaces.
- c. Submit information along with evidence demonstrating compliance with referenced standards. Submittals must include types of cementitious materials, manufacturing locations, shipping locations, and certificates showing compliance.
- d. Cementitious materials must be stored and kept dry and free from contaminants.

2.3.1.2 Fly Ash

Not permitted.

2.3.1.3 Other Supplementary Cementitious Materials

Natural pozzolan must be raw or calcined and conform to ASTM C618, Class N, including the optional requirement for uniformity.

2.3.2 Water

- a. Water or ice must comply with the requirements of ASTM C1602/C1602M.
- b. Minimize the amount of water in the mix. Improve workability by adjusting the grading of the aggregate and using admixture rather than by adding water. No water shall be added to mix at the job site.
- c. Water must be potable; free from injurious amounts of oils, acids, alkalis, salts, organic materials, or other substances deleterious to concrete.
- d. Protect mixing water and ice from contamination during storage and delivery.
- e. Submit test report showing water complies with ASTM C1602/C1602M.

2.3.3 Aggregate

Employ fine and coarse aggregate meeting ASTM C-33 (except that sand percentage passing #30 sieve may vary from 15 to 60). Use coarse aggregate Size 67 (¾" max. size) in typical concrete, Size 7 or 8 in other special mixes. Size 57 may be used in large footings. Submit laboratory tests from producer.

2.3.4 Admixtures

- a. Air-entraining admixtures must conform to ASTM C260/C260M.
- b. Do not use calcium chloride admixtures.
- c. Protect stored admixtures against contamination, evaporation, or damage.
- d. To ensure uniform distribution of constituents, provide agitating equipment for admixtures used in the form of suspensions or unstable solutions. Protect liquid admixtures from freezing and from temperature changes that would adversely affect their characteristics.
- . Submit types, brand names, producers' names, manufacturer's technical data sheets, and certificates showing compliance with standards required herein.

2.4 MISCELLANEOUS MATERIALS

2.4.1 Concrete Curing Materials

Provide concrete curing material in accordance with ACI 301 Section 5 and ACI 308.1 Section 2. Submit product data for concrete curing compounds. Submit manufactures instructions for placement of curing compound.

2.4.2 Nonshrink Grout

Nonshrink grout in accordance with ASTM C1107/C1107M.

2.4.3 Floor Finish Materials

2.4.3.1 Liquid Chemical Floor Hardeners and Sealers

- a. Hardener must be a colorless aqueous solution containing a blend of inorganic silicate or silicate material and proprietary components combined with a wetting agent; that penetrates, hardens, and densifies concrete surfaces. Submit manufacturers instructions for placement of liquid chemical floor hardener.
- b. Use concrete penetrating sealers with a low (maximum 100 grams/liter, less water and less exempt compounds) VOC content. Submit manufacturers instructions for placement of sealers.

2.4.4 Expansion/Contraction Joint Filler

ASTM D1751. Material must be 1/4 inch thick, cut to extend 1 inch below bottom of slab, unless otherwise indicated.

2.4.5 Vapor Barrier

ASTM E1745 Class C polyethylene sheeting, minimum 15 mil thickness or other equivalent material with a maximum permeance rating of 0.01 perms per ASTM E96/E96M.

Consider plastic vapor retarders and adhesives with a high recycled content, low toxicity low VOC (Volatile Organic Compounds) levels.

2.4.6 Dovetail Anchor Slot

Provide as shown and detailed, with maximum area bordered by construction joint or expansion held to 800 sf or less. Joints shall be formed type wood keyed joint (wood form to be removed). Coordinate actual size and throat opening with dovetail anchors and provide with removable filler material.

2.5 CONCRETE MIX DESIGN

2.5.1 Properties and Requirements

- a. Use materials and material combinations listed in this section and the contract documents.
- b. Cementitious material content must be adequate for concrete to satisfy the specified requirements for strength, w/cm, durability, and finishability described in this section and the contract documents.

The minimum cementitious material content for concrete used in floors must meet the following requirements:

Nominal maximum size of aggregate, in.	Minimum cementitious material content, pounds per cubic yard
1-1/2	470
1	520
3/4	540
3/8	610

- c. Selected target slump must meet the requirements this section, the contract documents, and must not exceed 9 in. Concrete must not show visible signs of segregation.
- d. The target slump must be enforced for the duration of the project. Determine the slump by ASTM C143/C143M. Slump tolerances must meet the requirements of ACI 117.
- e. The nominal maximum size of coarse aggregate for a mixture must not exceed three-fourths of the minimum clear spacing between reinforcement, one-fifth of the narrowest dimension between sides of forms, or one-third of the thickness of slabs or toppings.
- f. Measure air content at the point of delivery in accordance with ASTM C173/C173M or ASTM C231/C231M.
- g. Concrete for slabs to receive a hard-troweled finish must not contain an air-entraining admixture or have a total air content greater than 3 percent.

2.5.2 Strength:

Minimum 28-day compressive strength 3000 psi, except as otherwise noted.

Where drawings indicate a different strength for two elements, which are to be poured integrally, provide the higher strength for both.

2.5.3 Proportioning:

Establish proportions per ACI 318. Submit mix designs so determined for approval before work is started. Recent designs of same characteristics and determination will be accepted. Use maximum amount of coarse aggregate that will produce plastic, workable mix. Use not less than quantity of cement, and do not exceed quantity of water (which shall include any water in aggregate) as is tabulated below.

28 day strength	Min. cement pcy	Maximum water per bag of cement
2500 psi	4.75 bags	7.50 gal
3000 psi	5.25 bags	6.75 gal

Where water reducing admixture is employed, minimum cement content may be reduced up to 0.25 bag. Where #7 or #8 coarse aggregate is specified, increase minimum cement by 0.50 bag pcy.

2.5.4 Ready-Mix Concrete

Provide concrete that meets the requirements of ASTM C94/C94M.

Ready-mixed concrete manufacturer must provide duplicate delivery tickets with each load of concrete delivered. Provide delivery tickets with the following information in addition to that required by **ASTM C94/C94M**:

- a. Type and brand cement
- b. Cement and supplementary cementitious materials content in **94-pound** bags per cubic **yard** of concrete
- c. Maximum size of aggregate
- d. Amount and brand name of admixtures
- e. Total water content expressed by water cementitious material ratio

2.6 **REINFORCEMENT**

- a. Bend reinforcement cold. Fabricate reinforcement in accordance with fabricating tolerances of **ACI 117**.
- b. Submit manufacturer's certified test report for reinforcement.
- c. Submit placing drawings showing fabrication dimensions and placement locations of reinforcement and reinforcement supports. Placing drawings must indicate locations of splices, lengths of lap splices, and details of mechanical and welded splices.
- d. Submit request with locations and details of splices not indicated in Contract Documents.
- e. Submit request to place column dowels without using templates.
- f. Submit request for field cutting, including location and type of bar to be cut and reason field cutting is required.

2.6.1 **Reinforcing Bars**

- a. Reinforcing bars must be deformed, except spirals, load-transfer dowels, and welded wire reinforcement, which may be plain.
- b. **ASTM A615/A615M** deformed billet steel, Grade 60 unless noted otherwise. Free of loose rust, scale or other coating that will reduce bond. Provide plain bars where employed as slip dowels. Furnish mill certificates upon request.
- c. Submit mill certificates for reinforcing bars.

2.6.2 **Wire**

Welded wire fabric meeting ASTM A-185, having 75 KSI tensile strength; 6" x 6" x w1.4 / w1.4 unless indicated otherwise. Supply mesh heavier than w1.4 in flat sheets.

2.6.3 **Reinforcing Bar Supports**

- a. Provide reinforcement support types within structure as required by Contract Documents. Reinforcement supports must conform to **CRSI RB4.1**. Submit description of reinforcement supports and materials for

fastening coated reinforcement if not in conformance with **CRSI RB4.1**.

- b. Legs of supports in contact with formwork must be plastic coated after fabrication.
- c. Chairs on vapor barrier membrane shall have protector plates on legs. Provide #5 bars for stirrup supports where not shown otherwise. Provide chairs for conduit, which is not otherwise tied into proper position.

2.6.4 Dowels for Load Transfer in Floors

Provide greased dowels for load transfer in floors of the type, design, weight, and dimensions indicated. Provide dowel bars that are plain-billet steel conforming to **ASTM A615/A615M**, Grade 40. Provide dowel pipe that is steel conforming to **ASTM A53/A53M**.

2.6.5 Welding

- a. Provide weldable reinforcing bars that conform to **ASTM A706/A706M** and **ASTM A615/A615M** and Supplement S1, Grade 60, except that the maximum carbon content must be 0.55 percent.
- b. Comply with **AWS D1.4/D1.4M** unless otherwise specified. Do not tack weld reinforcing bars.
- c. Welded assemblies of steel reinforcement produced under factory conditions, such as welded wire reinforcement, bar mats, and deformed bar anchors, are allowed.

PART 3 EXECUTION

3.1 EXAMINATION

- a. Do not begin installation until substrates have been properly constructed; verify that substrates are level.
- b. If substrate preparation is the responsibility of another installer, notify Contracting Officer of unsatisfactory preparation before processing.
- c. Check field dimensions before beginning installation. If dimensions vary too much from design dimensions for proper installation, notify Contracting Officer and wait for instructions before beginning installation.

3.2 PREPARATION

Determine quantity of concrete needed and minimize the production of excess concrete. Designate locations or uses for potential excess concrete before the concrete is poured.

3.2.1 General

- a. Surfaces against which concrete is to be placed must be free of debris, loose material, standing water, snow, ice, and other deleterious substances before start of concrete placing.
- b. Remove standing water without washing over freshly deposited concrete.

Divert flow of water through side drains provided for such purpose.

3.2.2 Subgrade Under Foundations and Footings

- a. When subgrade material is semi-porous and dry, sprinkle subgrade surface with water as required to eliminate suction at the time concrete is deposited, or seal subgrade surface by covering surface with specified vapor retarder.
- b. When subgrade material is porous, seal subgrade surface by covering surface with specified vapor retarder.

3.2.3 Subgrade Under Slabs on Ground

- a. Before construction of slabs on ground, have underground work on pipes and conduits completed and approved.
- b. Previously constructed subgrade or fill must be cleaned of foreign materials
- c. Finish surface of capillary water barrier under interior slabs on ground must not show deviation in excess of **1/4 inch** when tested with a **10-foot** straightedge parallel with and at right angles to building lines.
- d. Finished surface of subgrade or fill under exterior slabs on ground must not be more than **0.02-foot** above or **0.10-foot** below elevation indicated.

3.2.4 Edge Forms and Screed Strips for Slabs

- a. Set edge forms or bulkheads and intermediate screed strips for slabs to obtain indicated elevations and contours in finished slab surface and must be strong enough to support vibrating bridge screeds or roller pipe screeds if nature of specified slab finish requires use of such equipment.
- b. Align concrete surface to elevation of screed strips by use of strike-off templates or approved compacting-type screeds.

3.2.5 Reinforcement and Other Embedded Items

- a. Secure reinforcement, joint materials, and other embedded materials in position, inspected, and approved before start of concrete placing.
- b. When concrete is placed, reinforcement must be free of materials deleterious to bond. Reinforcement with rust, mill scale, or a combination of both will be considered satisfactory, provided minimum nominal dimensions, nominal weight, and minimum average height of deformations of a hand-wire-brushed test specimen are not less than applicable ASTM specification requirements.

3.3 FORMS

- a. Provide forms, shoring, and scaffolding for concrete placement. Set forms mortar-tight and true to line and grade.
- b. **Except where noted otherwise, form beveled outside corners on exposed columns, beams and walls by molding placed in form. Include perimeter**

of wall openings where corners are exposed. Refer to details.
Terminate vertical chamfers 8 inches above floor and 6 inches below
ceilings, to permit base and ceiling material to fit properly.

- c. Provide formwork with clean-out openings to permit inspection and removal of debris.
- d. Inspect formwork and remove foreign material before concrete is placed.
- e. At construction joints, lap form-facing materials over the concrete of previous placement. Ensure formwork is placed against hardened concrete so offsets at construction joints conform to specified tolerances.
- f. Provide positive means of adjustment (such as wedges or jacks) of shores and struts. Do not make adjustments in formwork after concrete has reached initial setting. Brace formwork to resist lateral deflection and lateral instability.
- g. Fasten form wedges in place after final adjustment of forms and before concrete placement.
- h. Provide anchoring and bracing to control upward and lateral movement of formwork system.
- i. Construct formwork for openings to facilitate removal and to produce opening dimensions as specified and within tolerances.
- j. Provide runways for moving equipment. Support runways directly on formwork or structural members. Do not support runways on reinforcement. Loading applied by runways must not exceed capacity of formwork or structural members.
- k. Position and support expansion joint materials, waterstops, and other embedded items to prevent displacement. Fill voids in sleeves, inserts, and anchor slots temporarily with removable material to prevent concrete entry into voids.
- l. Clean surfaces of formwork and embedded materials of mortar, grout, and foreign materials before concrete placement.

3.3.1 Coating

- a. Cover formwork surfaces with an acceptable material that inhibits bond with concrete.
- b. If formwork release agent is used, apply to formwork surfaces in accordance with manufacturer's recommendations before placing reinforcement. Remove excess release agent on formwork prior to concrete placement.
- c. Do not allow formwork release agent to contact reinforcement or hardened concrete against which fresh concrete is to be placed.

3.3.2 Reshoring

- a. Do not allow structural members to be loaded with combined dead and construction loads in excess of loads indicated in the accepted procedure.

- b. Install and remove reshores or backshores in accordance with accepted procedure.
- c. For floors supporting shores under newly placed concrete, either leave original supporting shores in place, or install reshores or backshores. Shoring system and supporting slabs must resist anticipated loads. Locate reshores and backshores directly under a shore position or as indicated on formwork shop drawings.

3.3.3 Reuse

- a. Reuse forms providing the structural integrity of concrete and the aesthetics of exposed concrete are not compromised.
- b. Wood forms must not be clogged with paste and must be capable of absorbing high water-cementitious material ratio paste.
- c. Remove leaked mortar from formwork joints before reuse.

3.3.4 Forms for Standard Rough Form Finish

Provide formwork in accordance with [ACI 301](#) Section 5 with a surface finish, SF-1.0, for formed surfaces that are to be concealed by other construction.

3.3.5 Forms for Standard Smooth Form Finish

Provide formwork in accordance with [ACI 301](#) Section 5 with a surface finish, SF-3.0, for formed surfaces that are exposed to view.

3.3.6 Form Ties

- a. After ends or end fasteners of form ties have been removed, repair tie holes in accordance with [ACI 301](#) Section 5 requirements.

3.3.7 Tolerances for Form Construction

- a. Construct formwork so concrete surfaces conform to tolerances in [ACI 117](#).
- b. Position and secure sleeves, inserts, anchors, and other embedded items such that embedded items are positioned within [ACI 117](#) tolerances.
- c. To maintain specified elevation and thickness within tolerances, install formwork to compensate for deflection and anticipated settlement in formwork during concrete placement. Set formwork and intermediate screed strips for slabs to produce designated elevation, camber, and contour of finished surface before formwork removal. If specified finish requires use of vibrating screeds or roller pipe screeds, ensure that edge forms and screed strips are strong enough to support such equipment.

3.3.8 Removal of Forms and Supports

- a. If vertical formed surfaces require finishing, remove forms as soon as removal operations will not damage concrete.

- b. Remove top forms on sloping surfaces of concrete as soon as removal will not allow concrete to sag. Perform repairs and finishing operations required. If forms are removed before end of specified curing period, provide curing and protection.
- c. Do not damage concrete during removal of vertical formwork for columns, walls, and sides of beams. Perform needed repair and finishing operations required on vertical surfaces. If forms are removed before end of specified curing period, provide curing and protection.
- d. Leave formwork and shoring in place to support construction loads and weight of concrete in beams, slabs, and other structural members until in-place required strength of concrete is reached.
- e. Form-facing material and horizontal facing support members may be removed before in-place concrete reaches specified compressive strength if shores and other supports are designed to allow facing removal without deflection of supported slab or member.

3.3.9 Strength of Concrete Required for Removal of Formwork

If removal of formwork, reshoring, or backshoring is based on concrete reaching a specified in-place strength, mold and field-cure cylinders in accordance with [ASTM C31/C31M](#). Test cylinders in accordance with [ASTM C39/C39M](#). Alternatively, use one or more of the methods listed herein to evaluate in-place concrete strength for formwork removal.

- a. Tests of cast-in-place cylinders in accordance with [ASTM C873/C873M](#). This option is limited to slabs with concrete depths from 5 to 12 in.
- b. Penetration resistance in accordance with [ASTM C803/C803M](#).
- c. Pullout strength in accordance with [ASTM C900](#).
- d. Maturity method in accordance with [ASTM C1074](#). Submit [maturity method data](#) using project materials and concrete mix proportions used on the project to demonstrate the correlation between maturity and compressive strength of laboratory cured test specimens to the Contracting Officer.

3.4 PLACING REINFORCEMENT AND MISCELLANEOUS MATERIALS

- a. Unless otherwise specified, placing reinforcement and miscellaneous materials must be in accordance to [ACI 301](#). Provide bars, welded wire reinforcement, wire ties, supports, and other devices necessary to install and secure reinforcement.
- b. Reinforcement must not have rust, scale, oil, grease, clay, or foreign substances that would reduce the bond. Rusting of reinforcement is a basis of rejection if the effective cross-sectional area or the nominal weight per unit length has been reduced. Remove loose rust prior to placing steel. Tack welding is prohibited.
- c. Nonprestressed cast-in-place concrete members must have concrete cover for reinforcement given in the following table:

Concrete Exposure	Member	Reinforcement	Specified cover, in.
Cast against and permanently in contact with ground	All	All	3
Exposed to weather or in contact with ground	All	No. 6 through No. 18 bars	2
		No. 5 bar, W31 or D31 wire, and smaller	1-1/2
Not exposed to weather or in contact with ground	Slabs, joists, and walls	No. 14 and No. 18 bars	1-1/2
		No. 11 bar and smaller	3/4
	Beams, columns, pedestals, and tension ties	Primary reinforcement, stirrups, ties, spirals, and hoops	1-1/2

3.4.1 General

Provide details of reinforcement that are in accordance with the Contract Documents.

3.4.2 Vapor Barrier

- a. Install in accordance with **ASTM E1643**. Provide beneath the on-grade concrete floor slab. Use the greatest widths and lengths practicable to eliminate joints wherever possible. Lap joints a minimum of **12 inches** and tape.
- b. Place vapor barrier directly on underlying subgrade, base course, or capillary water barrier, unless it consists of crushed material or large granular material which could puncture the vapor barrier. In this case, a thin layer of approximately **1/2 inch** of fine graded material should be rolled or compacted over the fill before installation of the vapor barrier to reduce the possibility of puncture. Control concrete placement so as to prevent damage to the vapor barrier.

3.4.3 Perimeter Insulation

Install perimeter insulation at locations indicated. Adhesive must be used where insulation is applied to the interior surface of foundation walls and may be used for exterior application.

3.4.4 Reinforcement Supports

Provide reinforcement support in accordance with [CRSI RB4.1](#) and [ACI 301](#) Section 3 requirements.

3.4.5 Splicing

As indicated in the Contract Documents. For splices not indicated follow [ACI 301](#). Do not splice at points of maximum stress. Overlap welded wire reinforcement the spacing of the cross wires, plus [2 inches](#). [AWS D1.4/D1.4M](#). Approve welded splices prior to use.

3.4.6 Future Bonding

Plug exposed, threaded, mechanical reinforcement bar connectors with a greased bolt. Provide bolt threads that match the connector. Countersink the connector in the concrete. Caulk the depression after the bolt is installed.

3.4.7 Setting Miscellaneous Material

Place and secure anchors and bolts, pipe sleeves, conduits, and other such items in position before concrete placement and support against displacement. Plumb anchor bolts and check location and elevation. Temporarily fill voids in sleeves with readily removable material to prevent the entry of concrete.

3.4.8 Fabrication

Shop fabricate reinforcing bars to conform to shapes and dimensions indicated for reinforcement, and as follows:

- a. Provide fabrication tolerances that are in accordance with [ACI 117](#).
- b. Provide hooks and bends that are in accordance with the Contract Documents.

Reinforcement must be bent cold to shapes as indicated. Bending must be done in the shop. Rebending of a reinforcing bar that has been bent incorrectly is not be permitted. Bending must be in accordance with standard approved practice and by approved machine methods.

Deliver reinforcing bars bundled, tagged, and marked. Tags must be metal with bar size, length, mark, and other information pressed in by machine. Marks must correspond with those used on the placing drawings.

Do not use reinforcement that has any of the following defects:

- a. Bar lengths, depths, and bends beyond specified fabrication tolerances
- b. Bends or kinks not indicated on drawings or approved shop drawings
- c. Bars with reduced cross-section due to rusting or other cause

Replace defective reinforcement with new reinforcement having required shape, form, and cross-section area.

3.4.9 Placing Reinforcement

Place reinforcement in accordance with **ACI 301**.

For slabs on grade (over earth or over capillary water barrier) and for footing reinforcement, support bars or welded wire reinforcement on precast concrete blocks, spaced at intervals required by size of reinforcement, to keep reinforcement the minimum height specified above the underside of slab or footing.

For slabs other than on grade, supports for which any portion is less than **1 inch** from concrete surfaces that are exposed to view or to be painted must be of precast concrete units, plastic-coated steel, or stainless steel protected bar supports. Precast concrete units must be wedge shaped, not larger than **3-1/2 by 3-1/2 inches**, and of thickness equal to that indicated for concrete protection of reinforcement. Provide precast units that have cast-in galvanized tie wire hooked for anchorage and blend with concrete surfaces after finishing is completed.

Provide reinforcement that is supported and secured together to prevent displacement by construction loads or by placing of wet concrete, and as follows:

- a. Provide supports for reinforcing bars that are sufficient in number and have sufficient strength to carry the reinforcement they support, and in accordance with **ACI 301** and **CRSI 10MSP**. Do not use supports to support runways for concrete conveying equipment and similar construction loads.
- b. Equip supports on ground and similar surfaces with sand-plates.
- c. Support welded wire reinforcement as required for reinforcing bars.
- d. Secure reinforcements to supports by means of tie wire. Wire must be black, soft iron wire, not less than **16 gage**.
- e. Reinforcement must be accurately placed, securely tied at intersections, and held in position during placing of concrete by spacers, chairs, or other approved supports. Point wire-tie ends away from the form. Unless otherwise indicated, numbers, type, and spacing of supports must conform to the Contract Documents.
- f. Bending of reinforcing bars partially embedded in concrete is permitted only as specified in the Contract Documents.

3.4.10 Spacing of Reinforcing Bars

- a. Spacing must be as indicated in the Contract Documents.
- b. Reinforcing bars may be relocated to avoid interference with other reinforcement, or with conduit, pipe, or other embedded items. If any reinforcing bar is moved a distance exceeding one bar diameter or specified placing tolerance, resulting rearrangement of reinforcement is subject to preapproval by the Contracting Officer.

3.4.11 Concrete Protection for Reinforcement

Additional concrete protection must be in accordance with the Contract Documents.

3.4.12 Welding

Welding must be in accordance with AWS D1.4/D1.4M.

3.5 BATCHING, MEASURING, MIXING, AND TRANSPORTING CONCRETE

In accordance with ASTM C94/C94M, ACI 301, ACI 302.1R and ACI 304R, except as modified herein. Batching equipment must be such that the concrete ingredients are consistently measured within the following tolerances: 1 percent for cement and water, 2 percent for aggregate, and 3 percent for admixtures. Furnish mandatory batch ticket information for each load of ready mix concrete.

3.5.1 Measuring

Make measurements at intervals as specified in paragraphs SAMPLING and TESTING.

3.5.2 Mixing

- a. Mix concrete in accordance with ASTM C94/C94M, ACI 301 and ACI 304R.
- b. Machine mix concrete. Begin mixing within 30 minutes after the cement has been added to the aggregates. Place concrete within 90 minutes of either addition of mixing water to cement and aggregates or addition of cement to aggregates if the concrete temperature is less than 84 degrees F.
- c. Place concrete within 60 minutes if the concrete temperature is greater than 84 degrees F except as follows: if set retarding admixture is used and slump requirements can be met, limit for placing concrete may remain at 90 minutes. Additional water may be added, provided that both the specified maximum slump and submitted water-cementitious material ratio are not exceeded and the required concrete strength is still met. When additional water is added, an additional 30 revolutions of the mixer at mixing speed is required.
- d. If the entrained air content falls below the specified limit, add a sufficient quantity of admixture, within the manufacturer's recommended dosage, to bring the entrained air content within the specified limits. Dissolve admixtures in the mixing water and mix in the drum to uniformly distribute the admixture throughout the batch. Do not reconstitute concrete that has begun to solidify.

3.5.3 Transporting

Transport concrete from the mixer to the forms as rapidly as practicable. Prevent segregation or loss of ingredients. Clean transporting equipment thoroughly before each batch. Do not use aluminum pipe or chutes. Remove concrete which has segregated in transporting and dispose of as directed.

3.6 PLACING CONCRETE

Place concrete in accordance with ACI 301 Section 5. Concrete shall be placed within 15 minutes of discharge into non-agitating equipment.

3.6.1 Footing Placement

Concrete for footings may be placed in excavations without forms upon inspection and approval by the Contracting Officer. Excavation width must be a minimum of 4 inches greater than indicated.

3.6.2 Pumping

ACI 304R and ACI 304.2R. Pumping must not result in separation or loss of materials nor cause interruptions sufficient to permit loss of plasticity between successive increments. Loss of slump in pumping equipment must not exceed 2 inches at discharge/placement. Do not convey concrete through pipe made of aluminum or aluminum alloy. Avoid rapid changes in pipe sizes. Limit maximum size of coarse aggregate to 33 percent of the diameter of the pipe. Limit maximum size of well-rounded aggregate to 40 percent of the pipe diameter. Take samples for testing at both the point of delivery to the pump and at the discharge end.

3.6.3 Cold Weather

Cold weather concrete must meet the requirements of ACI 306.1 unless otherwise specified. Do not allow concrete temperature to decrease below 50 degrees F. Obtain approval prior to placing concrete when the ambient temperature is below 40 degrees F or when concrete is likely to be subjected to freezing temperatures within 24 hours. Cover concrete and provide sufficient heat to maintain 50 degrees F minimum adjacent to both the formwork and the structure while curing. Limit the rate of cooling to 37 degrees F in any one hour and 50 degrees F per 24 hours after heat application.

3.6.4 Hot Weather

Hot weather concrete must meet the requirements of ACI 305.1 unless otherwise specified. Maintain required concrete temperature using Figure 4.2 in ACI 305R to prevent the evaporation rate from exceeding 0.2 pound of water per square foot of exposed concrete per hour. Cool ingredients before mixing or use other suitable means to control concrete temperature and prevent rapid drying of newly placed concrete. Shade the fresh concrete as soon as possible after placing. Start curing when the surface of the fresh concrete is sufficiently hard to permit curing without damage. Provide water hoses, pipes, spraying equipment, and water hauling equipment, where job site is remote to water source, to maintain a moist concrete surface throughout the curing period. Provide burlap cover or other suitable, permeable material with fog spray or continuous wetting of the concrete when weather conditions prevent the use of either liquid membrane curing compound or impervious sheets. For vertical surfaces, protect forms from direct sunlight and add water to top of structure once concrete is set.

3.6.5 Bonding

Surfaces of set concrete at joints, must be roughened and cleaned of laitance, coatings, loose particles, and foreign matter. Roughen surfaces in a manner that exposes the aggregate uniformly and does not leave laitance, loosened particles of aggregate, nor damaged concrete at the surface.

Obtain bonding of fresh concrete that has set as follows:

- a. At joints between footings and walls or columns, between walls or columns and the beams or slabs they support, and elsewhere unless otherwise specified; roughened and cleaned surface of set concrete must be dampened, but not saturated, immediately prior to placing of fresh concrete.
- b. At joints in exposed-to-view work; at vertical joints in walls; at joints near midpoint of span in girders, beams, supported slabs, other structural members; in work designed to contain liquids; the roughened and cleaned surface of set concrete must be dampened but not saturated and covered with a cement grout coating.
- c. Provide cement grout that consists of equal parts of portland cement and fine aggregate by weight with not more than 6 gallons of water per sack of cement. Apply cement grout with a stiff broom or brush to a minimum thickness of 1/16 inch. Deposit fresh concrete before cement grout has attained its initial set.

3.7 WASTE MANAGEMENT

Provide as specified in the Waste Management Plan and as follows.

3.7.1 Mixing Equipment

Before concrete pours, designate on-site area to be paved later in project for cleaning out concrete mixing trucks. Minimize water used to wash equipment.

3.7.2 Hardened, Cured Waste Concrete

Crush and reuse hardened, cured waste concrete as fill or as a base course for pavement.

3.7.3 Reinforcing Steel

Collect reinforcing steel and place in designated area for recycling.

3.7.4 Other Waste

Identify concrete manufacturer's or supplier's policy for collection or return of construction waste, unused material, deconstruction waste, and/or packaging material.

3.8 SURFACE FINISHES EXCEPT FLOOR, SLAB, AND PAVEMENT FINISHES

3.8.1 Defects

Repair surface defects in accordance with ACI 301 Section 5.

3.8.2 Not Against Forms (Top of Walls)

Surfaces not otherwise specified must be finished with wood floats to even surfaces. Finish must match adjacent finishes.

3.8.3 Formed Surfaces

3.8.3.1 Tolerances

Tolerances in accordance with ACI 117 and as indicated.

3.8.3.2 As-Cast Rough Form

Provide for surfaces not exposed to public view a surface finish SF-1.0. Patch holes and defects in accordance with ACI 301.

3.8.3.3 Standard Smooth Finish

Provide for surfaces exposed to public view a surface finish SF-3.0. Patch holes and defects in accordance with ACI 301.

3.8.4 Smooth-Rubbed Finish

Provide a smooth-rubbed finish per ACI 301 Section 5 in the locations indicated.

3.9 FLOOR, SLAB, AND PAVEMENT FINISHES AND MISCELLANEOUS CONSTRUCTION

In accordance with ACI 301 and ACI 302.1R, unless otherwise specified. Slope floors uniformly to drains where drains are provided. Steel trowel and fine-broom finish new concrete slabs that are to receive porcelain tile. Where straightedge measurements are specified, Contractor must provide straightedge.

3.9.1 Finish

Place, consolidate, and immediately strike off concrete to obtain proper contour, grade, and elevation before bleedwater appears. Permit concrete to attain a set sufficient for floating and supporting the weight of the finisher and equipment. If bleedwater is present prior to floating the surface, drag the excess water off or remove by absorption with porous materials. Do not use dry cement to absorb bleedwater. Grate tampers ("jitterbugs") shall not be used.

3.9.1.1 Scratched

Use for surfaces intended to receive bonded applied cementitious applications. Finish concrete in accordance with ACI 301 Section 5 for a scratched finish.

3.9.1.2 Floated

Use for surfaces to receive roofing, waterproofing membranes, and exterior slabs where not otherwise specified. Finish concrete in accordance with ACI 301 Section 5 for a floated finish.

3.9.1.3 Steel Troweled

Use for floors intended as walking surfaces, and for reception of floor coverings. Finish concrete in accordance with ACI 301 Section 5 for a steel troweled finish.

3.9.1.4 Nonslip Finish

Use on surfaces of exterior platforms, steps, and landings; and on exterior and interior pedestrian ramps. Finish concrete in accordance with ACI 301 Section 5 for a dry-shake finish. After the selected material has been embedded by the two floatings, complete the operation with a broomed finish.

3.9.1.5 Broomed

Use on surfaces of exterior walks, platforms, patios, and ramps, unless otherwise indicated. Finish concrete in accordance with ACI 301 Section 5 for a broomed finish.

3.9.1.6 Flowable Mortar Trench Backfill

Ready Mix plant produced, flowable fill material composed of cement, sand, Class C or F fly ash, air entraining additives, and water, mixed to produce a 28 day strength of not less than 100 psi (nor more than 200 psi) per ASTM C39/C39M (modified to accommodate this material). Test cylinders shall be made in 4" x 8" molds without rodding or vibrating. Material shall be sufficiently flowable that vibration or spading is not required for consolidation. Hardened material shall resist penetration of a 1/2 inch reinforcing rod supporting the weight of a 150-pound man but shall be excavatable by hand using a pick and shovel. Utilize where noted in Section 31 00 00.

Where the material is employed as under paved areas, provide 500 psi minimum strength, and delete the excavatable requirement .

3.9.1.7 Mudslab:

Employ Ready Mixed Flowable Fill or other low-strength mix which shall be capable of supporting the floor slab after the water-proofing has been applied. Thickness shall be sufficient to support working loads without failure, but in no case less than 3 inches.

3.9.1.8 Pavement

Screed the concrete with a template advanced with a combined longitudinal and crosswise motion. Maintain a slight surplus of concrete ahead of the template. After screeding, float the concrete longitudinally. Use a straightedge to check slope and flatness; correct and refloat as necessary. Obtain final finish by a burlap drag. Drag a strip of clean, wet burlap from 3 to 10 feet wide and 2 feet longer than the pavement width across the slab. Produce a fine, granular, sandy textured surface without disfiguring marks. Round edges and joints with an edger having a radius of 1/8 inch.

3.9.2 Concrete Walks

Provide 4 inches thick minimum. Provide contraction joints spaced every 5 linear feet unless otherwise indicated. Cut contraction joints 1 inch deep, or one fourth the slab thickness whichever is deeper, with a jointing tool after the surface has been finished. Provide 0.5 inch thick transverse expansion joints at changes in direction where sidewalk abuts curb, steps, rigid pavement, or other similar structures; space expansion joints every 50 feet maximum. Give walks a broomed finish. Unless indicated otherwise, provide a transverse slope of 1/48. Limit variation in cross section to 1/4 inch in 5 feet.

3.9.3 Pits and Trenches

Place bottoms and walls monolithically or provide waterstops and keys.

3.9.4 Curbs and Gutters

Provide contraction joints spaced every 10 feet maximum unless otherwise indicated. Cut contraction joints 3/4 inch deep with a jointing tool after the surface has been finished. Provide expansion joints 1/2 inch thick and spaced every 100 feet maximum unless otherwise indicated. Perform pavement finish.

3.9.5 Splash Blocks

Provide at outlets of downspouts emptying at grade. Splash blocks may be precast concrete, and must be 24 inches long, 12 inches wide and 4 inches thick, unless otherwise indicated, with smooth-finished countersunk dishes sloped to drain away from the building.

3.10 JOINTS

3.10.1 Construction Joints

Make and locate joints not indicated so as not to impair strength and appearance of the structure, as approved. Joints must be perpendicular to main reinforcement. Reinforcement must be continued and developed across construction joints. Locate construction joints as follows:

3.10.1.1 Construction Joints for Constructability Purposes

- a. In walls, at top of footing; at top of slabs on ground; at top and bottom of door and window openings or where required to conform to architectural details; and at underside of deepest beam or girder framing into wall.
- b. In columns or piers, at top of footing; at top of slabs on ground; and at underside of deepest beam or girder framing into column or pier.
- c. Near midpoint of spans for supported slabs, beams, and girders unless a beam intersects a girder at the center, in which case construction joints in girder must offset a distance equal to twice the width of the beam. Make transfer of shear through construction joint by use of inclined reinforcement.

Provide keyways at least 1-1/2-inches deep in construction joints in walls and slabs and between walls and footings; approved bulkheads may be used for slabs.

3.10.2 Isolation Joints in Slabs on Ground

- a. Provide joints at points of contact between slabs on ground and vertical surfaces, such as column pedestals, foundation walls, grade beams, and elsewhere as indicated.
- b. Fill joints with premolded joint filler strips 1/2 inch thick, extending full slab depth. Install filler strips at proper level below finish floor elevation with a slightly tapered, dress-and-oiled wood strip temporarily secured to top of filler strip to form a groove not less than 3/4 inch in depth where joint is sealed with sealing compound and not less than 1/4 inch in depth where joint sealing is not required. Remove wood strip after concrete has set. Contractor must clean groove of foreign matter and loose particles after surface has dried.

3.10.3 Contraction Joints in Slabs on Ground

- a. Provide joints to form panels as indicated.
- b. Under and on exact line of each control joint, cut 50 percent of welded wire reinforcement before placing concrete.
- c. Sawcut contraction joints into slab on ground in accordance with **ACI 301** Section 5.
- d. Joints must be **1/8-inch** wide by 1/5 to 1/4 of slab depth and formed by inserting hand-pressed fiberboard strip into fresh concrete until top surface of strip is flush with slab surface. After concrete has cured for at least 7 days, the Contractor must remove inserts and clean groove of foreign matter and loose particles.

3.10.4 Sealing Joints in Slabs on Ground

- a. Contraction and control joints which are to receive finish flooring material must be sealed with joint sealing compound after concrete curing period. Slightly underfill groove with joint sealing compound to prevent extrusion of compound. Remove excess material as soon after sealing as possible.
- b. Sealed groove must be left ready to receive filling material that is provided as part of finish floor covering work.

3.11 CONCRETE FLOOR TOPPING

3.11.1 Standard Floor Topping

Provide topping for treads and platforms of metal steel stairs and elsewhere as indicated.

3.11.1.1 Preparations Prior to Placing

- a. When topping is placed on a green concrete base slab, screed surface of base slab to a level not more than **1-1/2 inches** nor less than **1 inch** below required finish surface. Remove water and laitance from surface of base slab before placing topping mixture. As soon as water ceases to rise to surface of base slab, place topping.
- b. When topping is placed on a hardened concrete base slab, remove dirt, loose material, oil, grease, asphalt, paint, and other contaminants from base slab surface, leaving a clean surface. Prior to placing topping mixture, **2-1/2-inches** minimum, slab surface must be dampened and left free of standing water. Immediately before topping mixture is placed, broom a coat of neat cement grout onto surface of slab. Do not allow cement grout to set or dry before topping is placed.
- c. When topping is placed on a metal surface, such as metal pans for steel stairs, remove dirt, loose material, oil, grease, asphalt, paint, and other contaminants from metal surface.

3.11.1.2 Placing

Spread standard topping mixture evenly on previously prepared base slab or metal surface, brought to correct level with a straightedge, and struck

off. Topping must be consolidated, floated, checked for trueness of surface, and refloated as specified for float finish.

3.11.1.3 Finishing

Give trowel finish standard floor topping surfaces.

Give other finishes standard floor topping surfaces as indicated.

3.11.2 Heavy-Duty Floor Topping

Provide topping where indicated.

3.11.2.1 Heavy-duty Topping Mixture

Provide mixture that consists of 1 part portland cement and 2-1/2 parts emery aggregate or 1 part fine aggregate and 1-1/2 parts traprock coarse aggregate, by volume. Exact proportions of mixture must conform to recommendations of aggregate manufacturer. Mixing water must not exceed 3-1/4 gallons per 94-pound sack of cement including unabsorbed moisture in aggregate. Maximum slump must be 1 inch.

3.11.2.2 Base Slab

- a. Screed surface of slab to a level no more than 1-1/2 inches nor less than 1 inch below grade of finished floor.
- b. Give slab a scratch finish as specified.
- c. Preparations prior to placing.

Remove dirt, loose material, oil, grease, asphalt, paint and other contaminants from base slab surface. Prior to placing topping mixture, dampen slab surface and leave free of standing water. Immediately before topping mixture is placed, broom a coat of neat cement grout onto surface of slab. Allow cement grout to set or dry before topping mixture is placed.

3.11.2.3 Placing

Spread heavy-duty topping mixture evenly on previously prepared base slab, and bring to correct level with a straightedge, and strike off. Provide topping that is consolidated, floated, and checked for trueness of surface as specified for float finish, except that power-driven floats is the impact type.

3.11.2.4 Finishing

Give trowel finish heavy-duty floor topping surfaces. Provide trowel finish as specified, except that additional troweling after first power troweling must be not less than three hand-troweling operations.

3.12 CURING, PROTECTION AND HARDENING

3.12.1 3.8.1. Protection:

Protect work from rapid drying, wash from heavy rain. Provide means to maintain temperature of 70 F for 3 days or 50 for 5 days. Follow applicable ACI recommendations for hot or cold weather placement.

Provide adequate shoring to protect from overloading by construction materials. Protect stair treads with boards carefully placed over kraft paper covering.

3.12.2 Membrane Curing

Membrane curing is required for typical slabs on grade. Cure surfaces by covering with large sheets of waterproof paper meeting ASTM C171 (Type 1) or 6 mil plastic sheet. Lap and seal edges with tape. Weight sheets to prevent displacement and immediately patch any tears occurring during curing period. Place membrane as soon as surfaces will bear weight of workmen, and leave in place at least six days.

3.12.3 Moist Curing

Moist curing is required for toppings over on grade without a membrane beneath, and for vertical and irregular surfaces not practical for membrane curing. Apply fine spray to surfaces for first 12 hours; as soon as surfaces will bear traffic cover with two inches soft wood shavings or clean sand. Keep moist for six days.

Cure vertical surfaces by loosening forms and allowing water to wet surface from top for full six day curing period. If forms are removed earlier, cover walls with burlap mats, which shall be kept continually wet.

3.12.4 Liquid Membrane Curing

Liquid Membrane curing is required for foundations and utility work. Liquid shall meet ASTM C309, Type 1-D, Class B, with fugitive dye. Apply in two coats as soon as concrete will bear weight, using lambs wool applicator or pressure sprayer. Apply second coat at right angle to the first. Keep all traffic off for 6 days and recoat areas where film is lost.

Liquid membrane curing cannot be used on other surfaces against which additional concrete or other material is to be bonded unless it is proven that the curing compound will not prevent bond, or unless positive measures are taken to remove it completely from areas to receive bonded applications. If liquid membrane curing is used, all manufacturers and trades that may be affected shall agree in writing that the use of the product will not adversely effect their applications.

3.13 FIELD QUALITY CONTROL

3.13.1 Concrete Sampling

ASTM C172/C172M. Collect samples of fresh concrete to perform tests specified. ASTM C31/C31M for making test specimens.

3.13.2 Concrete Testing

3.13.2.1 Slump Tests

ASTM C143/C143M. Take concrete samples during concrete placement/discharg; except that a single increment sample taken from the second half-yard of concrete discharged shall be used. If the sample fails to meet requirements, a second sample will be taken; upon failure of the second

sample, the load will be rejected; thereafter each load will be checked until proper consistency has been reestablished.

3.13.2.2 Temperature Tests

Test the concrete delivered and the concrete in the forms. Perform tests in hot or cold weather conditions (below 50 degrees F and above 80 degrees F) for each batch (minimum) or every 20 cubic yards (maximum) of concrete, until the specified temperature is obtained, and whenever test cylinders and slump tests are made.

3.13.2.3 Compressive Strength Tests

ASTM C39/C39M. Make at least one set of four test cylinders per ASTM C172 and ASTM C31/C31M for each 50 cubic yards or major fraction thereof, but not less than one set for each days concreting (of each type) in excess of 5 yards nor less than one set for each 3000 sf of surface area of walls and slabs. Take precautions to prevent evaporation and loss of water from the specimen. One specimen will be broken at 7 days per ASTM C-39 and two will be broken at 28 days. The fourth cylinder will be cured and held in reserve. Take samples for strength tests of each mix design. For the entire project, take no less than five sets of samples and perform strength tests for each mix design of concrete placed. Each strength test result must be the average of two cylinders from the same concrete sample tested at 28 days. Concrete compressive tests must meet the requirements of this section, the Contract Document, and ACI 301. If the break indicates any possibility of defective concrete, the lab will immediately seek instructions from the Contracting Officer regarding the curing and breaking of the fourth cylinder. Repair core holes with nonshrink grout. Match color and finish of adjacent concrete.

3.13.2.4 Air Content

ASTM C173/C173M or ASTM C231/C231M for normal weight concrete and ASTM C173/C173M for lightweight concrete. Make 5 air tests each time cylinders are taken. In addition, lab technicians will monitor the temperature of the mix and reject loads which are outside of the specified limits.

3.13.2.5 Strength of Concrete Structure

The strength of the concrete structure will be considered to be deficient if any of the following conditions are identified:

- a. Failure to meet compressive strength tests as evaluated.
- b. Reinforcement not conforming to requirements specified.
- c. Concrete which differs from required dimensions or location in such a manner as to reduce strength.
- d. Concrete curing and protection of concrete against extremes of temperature during curing, not conforming to requirements specified.
- e. Concrete subjected to damaging mechanical disturbances, particularly load stresses, heavy shock, and excessive vibration.
- f. Poor workmanship likely to result in deficient strength.

Where the strength of the concrete structure is considered deficient submit a mitigation or remediation plan for review and approval by the contracting officer.

3.13.2.6 Non-Conforming Materials

Factors that indicate that there are non-conforming materials include (but not limited to) excessive compressive strength, inadequate compressive strength, excessive slump, excessive voids and honeycombing, concrete delivery records that indicate excessive time between mixing and placement, or excessive water was added to the mixture during delivery and placement. Any of these indicators alone are sufficient reason for the Contracting Officer to request additional sampling and testing.

Investigations into non-conforming materials must be conducted at the Contractor's expense. The Contractor must be responsible for the investigation and must make written recommendations to adequately mitigate or remediate the non-conforming material. The Contracting Officer may accept, accept with reduced payment, require mitigation, or require removal and replacement of non-conforming material at no additional cost to the Government.

3.13.2.7 Testing Concrete Structure for Strength

When there is evidence that strength of concrete structure in place does not meet specification requirements or there are non-conforming materials, make cores drilled from hardened concrete for compressive strength determination in accordance with [ASTM C42/C42M](#), and as follows:

- a. Take at least three representative cores from each member or area of concrete-in-place that is considered potentially deficient. Location of cores will be determined by the Contracting Officer.
- b. Test cores after moisture conditioning in accordance with [ASTM C42/C42M](#) if concrete they represent is more than superficially wet under service.
- c. Air dry cores, ([60 to 80 degrees F](#) with relative humidity less than 60 percent) for 7 days before test and test dry if concrete they represent is dry under service conditions.
- d. Strength of cores from each member or area are considered satisfactory if their average is equal to or greater than 85 percent of the 28-day design compressive strength of the class of concrete.
- e. Core specimens will be taken and tested by the Government. If the results of core-boring tests indicate that the concrete as placed does not conform to the drawings and specification, the cost of such tests and restoration required must be borne by the Contractor.

Fill core holes solid with patching mortar and finished to match adjacent concrete surfaces.

Correct concrete work that is found inadequate by core tests in a manner approved by the Contracting Officer.

3.13.3 INSPECTIONS PURSUANT TO IBC CHAPTER 17

3.13.3.1 Special Inspectors:

In addition to the quality control procedures indicated above, the independent laboratory will provide the special inspectors mandated in Chapter 17 of the IBC for structural concrete. Laboratory personnel will inspect forms and re-steel, observe placement of concrete, note installation of cast-in-place bolts and inserts, verify that proper curing is provided, and issue reports, all to the extent and manner as is set forth in the Code.

Note: IBC special inspection monitoring is not required for footings of structures or wings of light frame construction less than 3 stories in height, for slab-on-grade, for toppings, for pavements nor for retaining walls not inherent to the building structure.

3.14 REPAIR, REHABILITATION AND REMOVAL

Before the Contracting Officer accepts the structure the Contractor must inspect the structure for cracks, damage and substandard concrete placements that may adversely affect the service life of the structure. A report documenting these defects must be prepared which includes recommendations for repair, removal or remediation must be submitted to the Contracting Officer for approval before any corrective work is accomplished.

3.14.1 Crack Repair

Prior to final acceptance, all cracks in excess of 0.02 inches wide must be documented and repaired. The proposed method and materials to repair the cracks must be submitted to the Contracting Officer for approval. The proposal must address the amount of movement expected in the crack due to temperature changes and loading.

3.14.2 Repair of Weak Surfaces

Weak surfaces are defined as mortar-rich, rain-damaged, uncured, or containing exposed voids or deleterious materials. Concrete surfaces with weak surfaces less than 1/4 inch thick must be diamond ground to remove the weak surface. Surfaces containing weak surfaces greater than 1/4 inch thick must be removed and replaced or mitigated in a manner acceptable to the Contracting Officer.

3.14.3 Failure of Quality Assurance Test Results

Proposed mitigation efforts by the Contractor must be approved by the Contracting Officer prior to proceeding.

-- End of Section --

SECTION 04 20 00

UNIT MASONRY

11/15, CHG 2: 05/19

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN CONCRETE INSTITUTE (ACI)

ACI SP-66 (2004) ACI Detailing Manual

ASTM INTERNATIONAL (ASTM)

ASTM A153/A153M (2016a) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware

ASTM A641/A641M (2019) Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire

ASTM A951/A951M (2011) Standard Specification for Steel Wire for Masonry Joint Reinforcement

ASTM C55 (2017) Standard Specification for Concrete Building Brick

ASTM C90 (2022) Standard Specification for Loadbearing Concrete Masonry Units

ASTM C270 (2019a; E 2019) Standard Specification for Mortar for Unit Masonry

ASTM C476 (2022) Standard Specification for Grout for Masonry

ASTM C494/C494M (2019; E 2022) Standard Specification for Chemical Admixtures for Concrete

ASTM C1019 (2019) Standard Test Method for Sampling and Testing Grout

ASTM C1384 (2012a) Standard Specification for Admixtures for Masonry Mortars

THE MASONRY SOCIETY (TMS)

TMS MSJC (2016) Masonry Standard Joint Committee's (MSJC) Book - Building Code Requirements and Specification for Masonry Structures, Containing TMS 402/ACI 530/ASCE 5, TMS 602/ACI 530.1/ASCE 6, and Companion Commentaries

1.2 SUBMITTALS

Government approval is required for submittals. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

- Cut CMU Drawings

- Reinforcement Detail Drawings

SD-03 Product Data

- Hot Weather Procedures

- Cold Weather Procedures

SD-04 Samples

- Mock-Up Panel

- Concrete Masonry Units (CMU)

- Concrete Brick

- Admixtures for Masonry Mortar

- Joint Reinforcement

SD-05 Design Data

- Bracing Calculations

SD-07 Certificates

- Concrete Masonry Units (CMU)

- Concrete Brick

- Admixtures for Masonry Mortar

- Admixtures for Grout

- Joint Reinforcement

SD-08 Manufacturer's Instructions

- Admixtures for Masonry Mortar

- Admixtures for Grout

SD-10 Operation and Maintenance Data

- Take-Back Program

1.3 QUALITY ASSURANCE

1.3.1 Masonry Mock-Up Panels

1.3.1.1 Mock-Up Panel Location

After material samples are approved and prior to starting masonry work, construct a **mock-up panel** for each type and color of masonry required. At least 48 hours prior to constructing the panel or panels, submit written notification to the Contracting Officer. Do not build-in mock-up panels as part of the structure; locate mock-up panels where directed. Construct portable mock-up panels or locate in an area where they will not be disrupted during construction.

1.3.1.2 Mock-Up Panel Configuration

Construct a masonry wall panel (6 feet x 4 feet minimum size) which demonstrates mortar, coursing, joints, tooling, corners, material, interior masonry finish, special features, masonry ties, etc. Panel shall verify component selections and, upon approval, will establish the standard of workmanship to be utilized throughout the job. Do not remove until directed. No masonry shall be laid until sample has been approved.

1.3.1.3 Mock-Up Panel Purpose

The completed panels is used as the standard of workmanship for the type of masonry represented. Do not commence masonry work until the mock-up panel for that type of masonry construction has been completed and approved. Protect panels from the weather and construction operations until the masonry work has been completed and approved. Perform cleaning procedures on the mockup and obtain approval of the Contracting Officer prior to cleaning the building. After completion of the work, completely remove the mock-up panel, including all foundation concrete, from the construction site.

1.3.2 Subcontractors

Subcontractors shall have been established in business for at least five years and shall have successfully completed at least four projects of equal size and complexity within the past 3 years.

1.3.3 Warranty:

Prior to beginning work call to the attention of the Contracting Officer any materials or detail of construction not considered adequate to produce a masonry system (weep holes, cavity, flashing, etc.) that will protect the interior of the building; otherwise any leaking of masonry walls shall constitute evidence of defective workmanship.

1.4 DELIVERY, STORAGE, AND HANDLING

Deliver, store, handle, and protect material to avoid chipping, breakage, and contact with soil or contaminating material. Store and prepare materials in already disturbed areas to minimize project site disturbance and size of project site.

1.4.1 Masonry Units

Cover and protect masonry units from precipitation. Conform to handling

and storage requirements of TMS MSJC.

- a. Mark prefabricated lintels on top sides to show either the lintel schedule number or the number and size of top and bottom bars.

1.4.2 Reinforcement, Anchors, and Ties

Store steel reinforcing bars, coated anchors, ties, and joint reinforcement above the ground. Maintain steel reinforcing bars and uncoated ties free of loose mill scale and loose rust.

1.4.3 Cementitious Materials, Sand and Aggregates

Deliver cementitious and other packaged materials in unopened containers, plainly marked and labeled with manufacturers' names and brands. Store cementitious material in dry, weathertight enclosures or completely cover. Handle cementitious materials in a manner that will prevent the inclusion of foreign materials and damage by water or dampness. Store sand and aggregates in a manner to prevent contamination and segregation.

1.5 PROJECT/SITE CONDITIONS

Conform to TMS MSJC for hot and cold weather masonry erection.

1.5.1 Hot Weather Procedures

When ambient air temperature exceeds 100 degrees F, or exceeds 90 degrees F and the wind velocity is greater than 8 mph, comply with TMS MSJC Article 1.8 D for: preparation prior to conducting masonry work; construction while masonry work is in progress; and protection for newly completed masonry.

1.5.2 Cold Weather Procedures

When ambient temperature is below 40 degrees F, comply with TMS MSJC Article 1.8 C for: preparation prior to conducting masonry work; construction while masonry work is in progress; and protection for newly completed masonry.

PART 2 PRODUCTS

2.1 MANUFACTURED UNITS

2.1.1 General Requirements

Do not change the source of materials, which will affect the appearance of the finished work, after the work has started except with Contracting Officer's approval. Submit test reports from an approved independent laboratory. Certify test reports on a previously tested material as the same materials as that proposed for use in this project. Submit certificates of compliance stating that the materials meet the specified requirements.

2.1.2 Concrete Masonry Units (CMU)

Steam-cured hollow load-bearing concrete masonry units meeting ASTM C90. Faces shall be uniform in texture and free of any defect which would impair the finish. Units shall not vary from designated size more than 1/16 inch. Typical units 7-5/8 inch high x 15-5/8 inch long x nominal

widths shown, two or three cell type. Furnish jamb, lintel, corner, filler, cap and other special shapes required. Submit sample of each type required for approval.

2.1.2.1 Typical Block

- a. Grade N units made with expanded slag, shale or clay aggregate.
- b. Edges shall be smooth and square, free of ragged corners, which would impair finish appearance.
- c. Units shall have smooth, dense, uniformly textured face suitable for paint finish without excessive filler.
- d. Weight of concrete utilized shall not exceed 110 pcf per ASTM C140/C140M (8" CMU weight shall not exceed 35 lb.).
- e. All 8 inch units shall meet International Building Code (Chapter 7) requirements for 2-hour fire resistance rating, and all 12 inch units shall meet 4-hour requirements.

2.1.2.2 Special Lintel Shapes:

Where block filled lintels (as opposed to bond beams) are indicated, employ "deep-round" shape (usual v-shape lintels will not be accepted). Where 16 inch deep block lintels are shown provide special 16 inch high "beam-lintels".

2.1.2.3 Concrete Brick

2.1.2.3.1 Common Concrete Brick

Provide common concrete brick conforming to ASTM C55 grade N. Install where brick indicated for bearing purpose in exposed areas above ground, using brick laying procedure.

2.2 EQUIPMENT

2.2.1 Vibrators

Maintain at least one spare vibrator on site at all times.

2.2.2 Grout Pumps

Pumping through aluminum tubes is not permitted.

2.3 MATERIALS

2.3.1 Mortar Materials

2.3.1.1 Admixtures for Masonry Mortar

In cold weather, use a non-chloride based accelerating admixture that conforms to ASTM C1384, unless Type III portland cement is used in the mortar.

At exterior locations and kitchens, use mortar that contains a water-repellent admixture that conforms to ASTM C1384 and of the same brand and manufacturer as the block's integral water-repellent, in the

mortar used to place concrete masonry units that have an integral water-repellent admixture.

2.3.1.2 Aggregate and Water

Provide aggregate (sand) and water that conform to materials permitted by [ASTM C270](#).

2.3.2 Grout and Ready-Mix Grout Materials

2.3.2.1 Cementitious Materials for Grout

Provide cementitious materials that conform to those permitted by [ASTM C476](#).

2.3.2.2 Admixtures for Grout

Water-reducing admixtures that conform to [ASTM C494/C494M](#) Type F or G and viscosity-modifying admixtures that conform to [ASTM C494/C494M](#) Type S are permitted for use in grout. Other admixtures require approval by the Contracting Officer.

In cold weather, a non-chloride based accelerating admixture may be used subject to approval by the Contracting Officer; use accelerating admixture that is non-corrosive and conforms to [ASTM C494/C494M](#), Type C.

2.3.2.3 Aggregate and Water

Provide fine and coarse aggregates and water that conform to materials permitted by [ASTM C476](#).

2.4 MORTAR AND GROUT MIXES

2.4.1 Mortar Mix

- a. For typical CMU walls: Mix as 1 part Type S masonry cement to 2.5 parts damp loose sand so as to produce [ASTM C270](#) Type S mortar.
- b. For Masonry Below Grade: Employ mix composed of one part Type M masonry cement, and 2.5 parts sand, so as to produce [ASTM C270](#) Type M mortar. Do not use in exposed work. Discard any that has not been used within one hour.
- c. For field-batched mortar, measure component materials by volume. Use measuring boxes for materials that do not come in packages, such as sand, for consistent batching. Mix cementitious materials and aggregates between 3 and 5 minutes in a mechanical batch mixer with a sufficient amount of water to produce a workable consistency. Do not hand mix mortar unless approved by the Contracting Officer. Maintain workability of mortar by remixing or retempering. Discard mortar that has begun to stiffen or is not used within 2-1/2 hours after initial mixing.
- d. For preblended mortar, follow manufacturer's mixing instructions.

2.4.2 Grout and Ready Mix Grout Mix

Use grout that conforms to [ASTM C476](#), coarse. Use conventional grout with a slump between [8 and 11 inches](#). Use self-consolidating grout with slump flow of [24 to 30 inches](#) and a visual stability index (VSI) not

greater than 1. Provide minimum grout strength of 3000 psi in 28 days, as tested in accordance with ASTM C1019. Do not change proportions and do not use materials with different physical or chemical characteristics in grout for the work unless additional evidence is furnished that grout meets the specified requirements. Use ready-mixed grout that conforms to ASTM C476.

2.5 ACCESSORIES

2.5.1 Grout Barriers

Grout barriers for vertical cores that consist of fine mesh wire, fiberglass, or expanded metal.

2.5.2 Joint Reinforcement

Factory fabricate joint reinforcement in conformance with ASTM A951/A951M, welded construction. Provide truss type joint reinforcement, having one longitudinal wire in the mortar bed of each face shell for hollow units and one wire for solid units and with all wires a minimum of 9 gauge. Size joint reinforcement to provide a minimum of 5/8 inch cover from each face. Space crosswires not more than 16 inches. Provide joint reinforcement for straight runs in flat sections not less than 10 feet long. Provide joint reinforcement with factory formed corners and intersections. If approved for use, joint reinforcement may be furnished with adjustable wall tie features. Submit one piece of each type used, including corner and wall intersection pieces, showing at least two cross wires.

At Interior CMU walls: Provide galvanized coating on wire per ASTM A641/A641M, Class 1 (0.4 osf)

At Exterior Single Wythe CMU Walls: Provide galvanized per ASTM A153/A153M, Class B-2 (1.5 osf)

PART 3 EXECUTION

3.1 EXAMINATION

Prior to start of work, verify the applicable conditions as set forth in TMS MSJC, inspection.

3.2 PREPARATION

3.2.1 Stains

Protect exposed surfaces from mortar and other stains. When mortar joints are tooled, remove mortar from exposed surfaces with fiber brushes and wooden paddles. Protect base of walls from splash stains by covering adjacent ground with sand, sawdust, or polyethylene.

3.2.2 Loads

Do not apply uniform loads for at least 12 hours or concentrated loads for at least 72 hours after masonry is constructed. Provide temporary bracing as required.

3.2.3 Concrete Surfaces

Where masonry is to be placed, clean concrete of laitance, dust, dirt, oil, organic matter, or other foreign materials and slightly roughen to provide a surface texture with a depth of at least $\frac{1}{8}$ inch. Sandblast, if necessary, to remove laitance from pores and to expose the aggregate.

3.2.4 Bracing

Provide bracing and scaffolding necessary for masonry work. Design bracing to resist wind pressure as required by OSHA and local codes and submit [bracing calculations](#), sealed by a registered professional engineer. Do not remove bracing in less than 10 days.

3.3 ERECTION

3.3.1 General

- a. Coordinate masonry work with the work of other trades to accommodate built-in items and to avoid cutting and patching. Lay masonry units in the indicated bond pattern. Lay facing courses level with back-up courses, unless the use of adjustable ties has been approved in which case the tolerances is plus or minus $\frac{1}{2}$ inch. Adjust each unit to its final position while mortar is still soft and has plastic consistency.
- b. Remove and clean units that have been disturbed after the mortar has stiffened, and relay with fresh mortar. Keep air spaces, cavities, chases, expansion joints, and spaces to be grouted free from mortar and other debris. Select units to be used in exposed masonry surfaces from those having the least amount of chipped edges or other imperfections detracting from the appearance of the finished work.
- c. When necessary to temporarily discontinue the work, step (rack) back the masonry for joining when work resumes. Tothing may be used only when specifically approved by the Contracting Officer. Before resuming work, remove loose mortar and thoroughly clean the exposed joint. Cover the top of walls subjected to rain or snow with nonstaining waterproof covering or membrane when work is not in process. Extend the covering a minimum of 610 mm 2 feet down on each side of the wall and hold securely in place.
- d. Ensure that units being laid and surfaces to receive units are free of water film and frost. Lay solid units in a nonfurrowed full bed of mortar. Bevel mortar for veneer wythes and slope down toward the cavity side. Shove units into place so that the vertical joints are tight. Completely fill vertical joints between solid units with mortar, except where indicated at control, expansion, and isolation joints. Place hollow units so that mortar extends to the depth of the face shell at heads and beds, unless otherwise indicated. Mortar will be permitted to protrude up to $\frac{1}{2}$ inch into the space or cells to be grouted. Provide means to prevent mortar from dropping into the space below or clean grout spaces prior to grouting.
- e. All exposed block shall be free from broken corners and other imperfections. All partial block shall be cut with a masonry saw and every effort shall be made to dry the units prior to laying in wall (color-added units shall be cut with a dry saw). Otherwise, do not wet block or allow to become wet before or during laying of wall.

- f. In multi-wythe construction with collar joints no more than $\frac{3}{4}$ inch wide, bring up the inner wythe not more than 16 inches ahead of the outer wythe. Fill collar joints with mortar during the laying of the facing wythe, and do not lag the laying of the facing wythe by back-buttering each unit as it is laid.

3.3.1.1 Jointing

Tool mortar joints when the mortar is thumbprint hard. Tool horizontal joints after tooling vertical joints. Brush mortar joints to remove loose and excess mortar.

3.3.1.1.1 Tooled Joints

Tool mortar joints in exposed exterior and interior masonry surfaces concave, using a jointer that is slightly larger than the joint width so that complete contact is made along the edges of the unit. Perform tooling so that the mortar is compressed and the joint surface is sealed. Use a jointer of sufficient length to obtain a straight and true mortar joint. No exterior joints are to be left un-tooled.

3.3.1.1.2 Flush Joints

Flush cut mortar joints in concealed masonry surfaces and joints at electrical outlet boxes in wet areas. Finish flush cut joints by cutting off the mortar flush with the face of the wall. Point joints in unparged masonry walls below grade tight. For architectural units, such as fluted units, completely fill both the head and bed joints and flush cut.

3.3.1.1.3 Door and Window Frame Joints

On the exposed interior side of exterior frames, rake joints between frames and abutting masonry walls to a depth of $\frac{3}{8}$ inch. On the exterior side of exterior frames, rake joints between frames and abutting masonry walls to a depth of $\frac{3}{8}$ inch.

3.3.1.1.4 Joint Widths

- a. Construct brick masonry with mortar joint widths equal to the difference between the specified and nominal dimensions of the unit, within tolerances permitted by TMS MSJC.
- b. Provide $\frac{3}{8}$ inch wide mortar joints in concrete masonry, except for prefaced concrete masonry units.
- c. Provide $\frac{3}{8}$ inch wide mortar joints on unfaced side of prefaced concrete masonry units and not less than $\frac{3}{16}$ inch nor more than $\frac{1}{4}$ inch wide on prefaced side.
- d. Maintain mortar joint widths within tolerances permitted by TMS MSJC

3.3.1.2 Cutting and Fitting

Use full units of the proper size wherever possible, in lieu of cut units. Locate cut units where they would have the least impact on the architectural aesthetic goals of the facility. Perform cutting and fitting, including that required to accommodate the work of others, by masonry mechanics using power masonry saws. Concrete masonry units may be

wet or dry cut. Before being placed in the work, dry wet-cut units to the same surface-dry appearance as uncut units being laid in the wall. Provide cut edges that are clean, true and sharp.

- a. Carefully make openings in the masonry so that wall plates, cover plates or escutcheons required by the installation will completely conceal the openings and will have bottoms parallel with the masonry bed joints. Provide reinforced masonry lintels above openings over 12 inches wide for pipes, ducts, cable trays, and other wall penetrations, unless steel sleeves are used.
- b. Do not reduce masonry units in size by more than one-third in height and one-half in length. Do not locate cut products at ends of walls, corners, and other openings.

3.3.1.3 Unfinished Work

Rack back unfinished work for joining with new work. Tooothing may be resorted to only when specifically approved by the Contracting Officer. Remove loose mortar and thoroughly clean the exposed joints before laying new work.

3.3.1.4 Control Joints

Provide control joints in concrete masonry as indicated. Construct by raking out mortar within the head joint in accordance with the details shown on the Drawings. Form a continuous vertical joint at control joint locations, including through bond beams, by utilizing half blocks in alternating courses on each side of the joint. Interrupt the control joint key in courses containing continuous bond beam reinforcement. Do not interrupt the horizontal reinforcement and grout at the control joint.

Where mortar was placed in the joint, rake both faces of the control joints to a depth of 3/4 inch. Install backer rod and sealant on both faces in accordance with Section 07 92 00 JOINT SEALANTS.

3.3.2 Reinforced, Single Wythe Concrete Masonry Units Walls

3.3.2.1 Concrete Masonry Unit Placement

- a. Fully bed units used to form piers, pilasters, columns, starting courses on footings, solid foundation walls, lintels, and beams, and where cells are to be filled with grout in mortar under both face shells and webs. Provide mortar beds under both face shells for other units. Mortar head joints for a distance in from the face of the unit not less than the thickness of the face shell.
- b. Solidly grout foundation walls below grade.
- c. Stiffen double walls at wall-mounted plumbing fixtures by use of strap anchors, two above each fixture and two below each fixture, located to avoid pipe runs, and extending from center to center of each wall within the double wall. Adequately reinforce walls and partitions for support of wall-hung plumbing fixtures when chair carriers are not specified.
- d. Submit drawings showing elevations of walls exposed to view and indicating the location of all cut CMU products.

3.3.2.2 Preparation for Reinforcement

Lay units in such a manner as to preserve the unobstructed vertical continuity of cores to be grouted. Remove mortar protrusions extending $\frac{1}{2}$ inch or more into cells before placing grout. Position reinforcing bars accurately as indicated before placing grout. Where vertical reinforcement occurs, fill cores solid with grout in accordance with paragraph PLACING GROUT in this Section.

3.3.3 ANCHORAGE

3.3.3.1 Anchorage to Concrete

Anchor masonry to the face of concrete columns, beams, or walls with dovetail anchors spaced not over 16 inches on centers vertically and 24 inches on center horizontally.

3.3.3.2 Anchorage at Intersecting Walls

Provide wire mesh anchors at maximum 16 inches spacing at intersections of interior non-bearing masonry walls.

Anchor structural masonry walls with horizontal joint reinforcement spaced no more than 16 feet on center, unless the drawings indicate a movement joint at the intersection.

3.3.4 Lintels

3.3.4.1 Masonry Lintels

Construct masonry lintels with lintel units filled solid with grout in all courses and reinforced with a minimum of two No. 4 bars in the bottom course unless otherwise indicated. Extend lintel reinforcement beyond each side of masonry opening 40 bar diameters or 24 inches, whichever is greater. Support reinforcing bars in place prior to grouting and locate $\frac{1}{2}$ inch above the bottom inside surface of the lintel unit.

3.3.5 Sills and Copings

Set sills and copings in a full bed of mortar with faces plumb and true. Slope sills and copings to drain water. Mechanically anchor copings and sills longer than 4 feet as indicated.

3.4 INSTALLATION

3.4.1 Bar Reinforcement Installation

3.4.1.1 Preparation

Submit reinforcement detail drawings showing bar splice locations. Identify bent bars on a bending diagram and reference and locate such bars on the drawings. Show wall dimensions, bar clearances, and wall openings. Utilize bending details that conform to the requirements of ACI SP-66. No approval will be given to the shop drawings until the Contractor certifies that all openings, including those for mechanical and electrical service, are shown. If, during construction, additional masonry openings are required, resubmit the approved shop drawings with the additional openings shown along with the proposed changes. Clearly highlight location of these additional openings. Provide wall elevation

drawings with minimum scale of **1/4 inch per foot**. Submit drawings including plans, elevations, and details of wall reinforcement; details of reinforcing bars at corners and wall intersections; offsets; tops, bottoms, and ends of walls; control and expansion joints; lintels; and wall openings.

Clean reinforcement of loose, flaky rust, scale, grease, mortar, grout, and other coatings that might destroy or reduce its bond prior to placing grout. Do not use bars with kinks or bends not shown on the approved shop drawings. Place reinforcement prior to grouting. Unless otherwise indicated, extend vertical wall reinforcement to within **2 inches** of tops of walls.

3.4.1.2 Positioning Bars

- a. Accurately place vertical bars within the cells at the positions indicated on the drawings. Maintain a minimum clearance of **1/2 inch** between the bars and masonry units. Provide minimum clearance between parallel bars of **1/2 inch** between the bars and masonry units for coarse grout and a minimum clearance of **1/4 inch** between the bars and masonry units for fine grout. Provide minimum clearance between parallel bars of **1 inch** or one diameter of the reinforcement, whichever is greater. Vertical reinforcement may be held in place using bar positioners located near the ends of each bar and at intermediate intervals of not more than 192 diameters of the reinforcement or by other means to prevent displacement beyond permitted tolerances. As masonry work progresses, secure vertical reinforcement to prevent displacement beyond allowable tolerances.
- b. Wire column and pilaster lateral ties in position around the vertical reinforcing bars. Place lateral ties in contact with the vertical reinforcement and do not place in horizontal mortar bed joints.
- c. Position horizontal reinforcing bars as indicated. Stagger splices in adjacent horizontal bars, unless otherwise indicated.
- d. Form splices by lapping bars as indicated. Do not cut, bend or eliminate reinforcing bars. Foundation dowel bars may be field-bent when permitted by **TMS MSJC**.

3.4.1.3 Splices of Bar Reinforcement

Lap splice reinforcing bars as indicated. When used, provide welded or mechanical connections that develop at least 125 percent of the specified yield strength of the reinforcement.

3.4.2 Placing Grout

3.4.2.1 General

Reinforce and grout-fill block cells where indicated. Select shapes and align cells to produce the maximum practical continuous open cell to receive the reinforcing and grout.

Unless other conditions are specifically detailed, solidly grout cores for at least 24 inches below bearing plates, lintels, and similar features and conditions.

Secure reinforcement accurately at locations indicated and to avoid

displacement. The minimum spacing between bars or to masonry surfaces shall be bar diameter or 1/4 inch for fine grout and 1/2 inch for coarse grout, whichever is greater. Lap-splices shall be 48 diameter (per ACI 530).

Discard site-mixed grout that is not placed within 1-1/2 hours after water is first added to the batch or when the specified slump is not met without adding water after initial mixing. Discard ready-mixed grout that does not meet the specified slump without adding water other than water that was added at the time of initial discharge. Allow sufficient time between grout lifts to preclude displacement or cracking of face shells of masonry units. Provide a grout shear key between lifts when grouting is delayed and the lower lift loses plasticity. If blowouts, flowouts, misalignment, or cracking of face shells should occur during construction, tear down the wall and rebuild.

3.4.3 Joint Reinforcement Installation

Install joint reinforcement at 16 inches on center unless otherwise indicated. Lap joint reinforcement not less than 6 inches. Install prefabricated sections at corners and wall intersections. Place the longitudinal wires of joint reinforcement in mortar beds to provide not less than 5/8 inch cover to either face of the unit.

3.4.4 Bond Beams

Reinforce and grout bond beams as indicated and as described in paragraphs above. Install grout barriers under bond beam units to retain the grout as required, unless wall is fully grouted or solid bottom units are used. For high lift grouting in partially grouted masonry, provide grout retaining material on the top of bond beams to prevent upward flow of grout. Ensure that reinforcement is continuous, including around corners, except through control joints or expansion joints, unless otherwise indicated.

3.4.5 Flashing and Weeps

- a. Install through-wall flashing at obstructions in the cavity and where indicated on Drawings. Ensure continuity of the flashing at laps and inside and outside corners by splicing in a manner approved by the flashing manufacturer. Ensure that the top edge of the flashing is sealed by turning the flashing 1/2 inch into the mortar bed joint of backup masonry. Terminate the horizontal leg of the flashing by extending the sheet metal 1/2 inch beyond the outside face of masonry and turning downward with a hemmed drip. Provide sealant below the drip edge of through-wall flashing.
- b. Wherever through-wall flashing occurs, provide weep holes to drain flashing to exterior at acceptable locations as indicated. Provide weeps of open head joints. Locate weeps not more than 24 inches on centers in mortar joints of the exterior wythe directly on the horizontal leg of through-wall flashing over foundations, bond beams, and any other horizontal interruptions of the cavity. Place weep holes perfectly horizontal or slightly canted downward to encourage water drainage outward and not inward. Other methods may be used for providing weeps when spacing is reduced to 16 inches on center and approved by the Contracting Officer. Maintain weeps free of mortar and other obstructions.

- c. Install single-wythe CMU flashing system in bed joints of CMU walls where CMU cells are open. Install CMU cell pans with upturned edges located below face shells and webs of CMUs above and with weep spouts aligned with face of wall on the exterior side. Install CMU web covers so that they cover upturned edges of CMU cell pans at CMU webs and extend from face shell to face shell.

3.5 APPLICATION

3.5.1 Interface with Other Products

3.5.1.1 Built-In Items

Fill spaces around built-in items with mortar. Point openings around flush-mount electrical outlet boxes in wet locations with mortar. Embed anchors, ties, wall plugs, accessories, flashing, pipe sleeves and other items required to be built-in as the masonry work progresses. Fully embed anchors, ties and joint reinforcement in the mortar. Fill cells receiving anchor bolts and cells of the first course below bearing plates with grout, unless otherwise indicated.

3.5.1.2 Door and Window Frame Joints

On the exposed interior and exterior sides of exterior frames, rake joints between frames and abutting masonry walls to a depth of $\frac{3}{8}$ inch.

3.5.2 Tolerances

Lay masonry plumb, true to line, with courses level within the tolerances of TMS MSJC, Article 3.3 F.

3.6 FIELD QUALITY CONTROL

3.6.1 Special Inspection

Perform special inspections and testing

3.7 POINTING AND CLEANING

After mortar joints have attained their initial set, but prior to hardening, completely remove mortar and grout daubs and splashings from masonry-unit surfaces that will be exposed or painted. Before completion of the work, rake out defects in joints of masonry that are not fully bonded, are to be exposed or painted; fill with mortar, and tool to match existing joints. Immediately after grout work is completed, remove scum and stains that have percolated through the masonry work using a low pressure stream of water and a stiff bristled brush. Do not clean masonry surfaces, other than removing excess surface mortar, until mortar in joints has hardened. Leave masonry surfaces clean, free of mortar daubs, dirt, stain, and discoloration, including scum from cleaning operations, and with tight mortar joints throughout. Do not use metal tools and metal brushes for cleaning.

3.7.1 Dry-Brushing Concrete Masonry

Dry brush exposed concrete masonry surfaces at the end of each day's work and after any required pointing, using stiff-fiber bristled brushes.

3.8 CLOSE-OUT TAKE-BACK PROGRAM

Collect information from manufacturer for take-back program options. Set aside masonry units, full and partial to be returned to manufacturer for recycling into new product. When such a service is not available, seek local recyclers to reclaim the materials. Submit documentation that includes contact information, summary of procedures, and the limitations and conditions applicable to the project. Indicate manufacturer's commitment to reclaim materials for recycling and/or reuse.

3.9 PROTECTION

Protect facing materials against staining. Cover top of walls with nonstaining waterproof covering or membrane to protect from moisture intrusion when work is not in progress. Continue covering the top of the unfinished walls until the wall is waterproofed with a complete roof or parapet system. Extend covering a minimum of 2 feet down on each side of the wall and hold securely in place. Before starting or resuming work, clean top surface of masonry in place of loose mortar and foreign material.

-- End of Section --

SECTION 05 50 13

MISCELLANEOUS METAL FABRICATIONS
05/17, CHG 1: 08/18

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ALUMINUM ASSOCIATION (AA)

AA DAF45 (2003; Reaffirmed 2009) Designation System
for Aluminum Finishes

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 303 (2016) Code of Standard Practice for Steel
Buildings and Bridges

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B18.2.1 (2012; Errata 2013) Square and Hex Bolts
and Screws (Inch Series)

ASME B18.2.2 (2022) Nuts for General Applications:
Machine Screw Nuts, and Hex, Square, Hex
Flange, and Coupling Nuts (Inch Series)

ASME B18.6.2 (2020) Square Head Set Screws and Slotted
Headless Set Screws (Inch Series)

ASME B18.6.3 (2013; R 2017) Machine Screws, Tapping
Screws, and Machine Drive Screws (Inch
Series)

ASME B18.21.1 (2009; R 2016) Washers: Helical
Spring-Lock, Tooth Lock, and Plain Washers
(Inch Series)

ASME B18.21.2M (1999; R 2014) Lock Washers (Metric Series)

ASME B18.22M (1981; R 2017) Metric Plain Washers

AMERICAN SOCIETY OF SAFETY PROFESSIONALS (ASSP)

ASSP A10.3 (2020) Safety Requirements for
Powder-Actuated Fastening Systems American
National Standard for Construction and
Demolition Operations

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M (2020; Errata 1 2021) Structural Welding
Code - Steel

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A47/A47M	(1999; R 2022; E 2022) Standard Specification for Ferritic Malleable Iron Castings
ASTM A48/A48M	(2003; R 2021) Standard Specification for Gray Iron Castings
ASTM A53/A53M	(2022) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A123/A123M	(2017) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2016a) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A307	(2021) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM A500/A500M	(2021a) Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A653/A653M	(2022) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A780/A780M	(2020) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM A924/A924M	(2022a) Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
ASTM B26/B26M	(2018; E 2018) Standard Specification for Aluminum-Alloy Sand Castings
ASTM B108/B108M	(2019) Standard Specification for Aluminum-Alloy Permanent Mold Castings
ASTM B209	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B209M	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric)

ASTM B221	(2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM B221M	(2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric)
ASTM C1513	(2018) Standard Specification for Steel Tapping Screws for Cold-Formed Steel Framing Connections
ASTM D1187/D1187M	(1997; E 2011; R 2011) Asphalt-Base Emulsions for Use as Protective Coatings for Metal
ASTM F1554	(2020) Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength

MASTER PAINTERS INSTITUTE (MPI)

MPI 79	(2016) Primer, Alkyd, Anti-Corrosive for Metal

NATIONAL ASSOCIATION OF ARCHITECTURAL METAL MANUFACTURERS (NAAMM)

NAAMM MBG 531	(2017) Metal Bar Grating Manual

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC SP 1	(2015) Solvent Cleaning
SSPC SP 3	(2018) Power Tool Cleaning

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1	(2014) Safety -- Safety and Health Requirements Manual

1.2 SUBMITTALS

Government approval is required for submittals. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Embedded Angles and Plates, Installation Drawings

Roof Hatches, Installation Drawings

Ladders

SD-03 Product Data

Roof Hatches

Each Downspout Terminations Type

Recycled Content

1.3 QUALIFICATION OF WELDERS

Qualify welders in accordance with AWS D1.1/D1.1M. Use procedures, materials, and equipment of the type required for the work.

1.4 DELIVERY, STORAGE, AND PROTECTION

Protect from corrosion, deformation, and other types of damage. Store items in an enclosed area free from contact with soil and weather. Remove and replace damaged items with new items.

1.5 MISCELLANEOUS REQUIREMENTS

1.5.1 Fabrication Drawings

Submit fabrication drawings showing layout(s), connections to structural system, and anchoring details as specified in AISC 303.

1.5.2 Installation Drawings

Submit templates, erection, and installation drawings indicating thickness, type, grade, class of metal, and dimensions. Show construction details, reinforcement, anchorage, and installation in relation to the building construction.

PART 2 PRODUCTS

2.1 RECYCLED CONTENT

Provide products with recycled content.

2.2 MATERIALS

Provide exposed fastenings of compatible materials (avoid contact of dissimilar metals). Coordinate color and finish with the material to which fastenings are applied.

2.2.1 Structural Carbon Steel

Provide in accordance with ASTM A36/A36M.

2.2.2 Structural Tubing

Provide in accordance with ASTM A500/A500M.

2.2.3 Steel Pipe

Provide in accordance with ASTM A53/A53M, Type E or S, Grade B.

2.2.4 Fittings for Steel Pipe

Provide standard malleable iron fittings in accordance with ASTM A47/A47M.

2.2.5 Gratings

a. Provide gray cast iron in accordance with ASTM A48/A48M, Class 40.

- b. Provide metal plank grating, non-slip requirement, steel in accordance with [ASTM A653/A653M](#), Z275 G90.
- c. Provide metal bar type grating in accordance with [NAAMM MBG 531](#).

2.2.6 Anchor Bolts

Provide in accordance with [ASTM F1554](#).

Provide as indicated or required to complete the work. Bolts and washers exposed to the elements shall be galv. or cadmium plated. Expansion bolts shall be lead sleeve type. Powder driven fasteners shall be equal to Ramset PD, of suitable type, sized to penetrate concrete a distance equal to 6 to 8 times diameter of shank, placed not closer than 3" to edge, and placed not sooner than 21 days after pouring concrete. Where spalling occurs patch surface and replace stud with new fasteners driven nearby.

Provide Stainless steel bolts in pressure treated lumber.

2.2.6.1 Lag Screws and Bolts

Provide in accordance with [ASME B18.2.1](#), type and grade best suited for the purpose.

2.2.6.2 Toggle Bolts

Provide in accordance with [ASME B18.2.1](#).

2.2.6.3 Bolts, Nuts, Studs and Rivets

Provide in accordance with [ASME B18.2.2](#) or [ASTM A307](#).

2.2.6.4 Powder Actuated Fasteners

Follow safety provisions in accordance with [ASSP A10.3](#).

2.2.6.5 Screws

Provide in accordance with [ASME B18.2.1](#), [ASME B18.6.2](#), [ASME B18.6.3](#) and [ASTM C1513](#).

2.2.6.6 Washers

Provide plain washers in accordance with [ASME B18.22M](#), [ASME B18.21.1](#). Provide beveled washers for American Standard beams and channels, square or rectangular, tapered in thickness, and smooth. Provide lock washers in accordance with [ASME B18.21.2M](#), [ASME B18.21.1](#).

2.2.7 Aluminum Alloy Products

Provide in accordance with [ASTM B209M](#), [ASTM B209](#) for sheet plate, [ASTM B221M](#), [ASTM B221M](#), [ASTM B221](#) for extrusions and [ASTM B26/B26M](#) or [ASTM B108/B108M](#) for castings. Provide aluminum extrusions at least [1/8 inch](#) thick and aluminum plate or sheet at least [0.050 inch](#) thick.

2.3 FABRICATION FINISHES

2.3.1 Galvanizing

Hot-dip galvanize items specified to be zinc-coated, after fabrication

where practicable. Provide galvanizing in accordance with ASTM A123/A123M, ASTM A153/A153M, ASTM A653/A653M or ASTM A924/A924M, Z275 G90.

2.3.2 Galvanize

Anchor bolts, grating fasteners, washers, and parts or devices necessary for proper installation, unless indicated otherwise.

2.3.3 Repair of Zinc-Coated Surfaces

Repair damaged surfaces with galvanizing repair method and paint in accordance with ASTM A780/A780M or by application of stick or thick paste material specifically designed for repair of galvanizing, as approved by Contracting Officer. Clean areas to be repaired and remove slag from welds. Heat, with a torch, surfaces to which stick or paste material will be applied. Heat to a temperature sufficient to melt the metals in the stick or paste. Spread molten material uniformly over surfaces to be coated and wipe off excess material.

2.3.4 Shop Cleaning and Painting

2.3.4.1 Surface Preparation

Clean all ferrous non-galvanized shop items per SSPC SP 1 and SSPC SP 3, and give one shop coat of red primer. After erection touch up welds and damaged places with same primer (but green in color). Then apply field coat of same primer (but green in color) to all items, which are to be embedded in masonry or otherwise concealed from view.

Wash cleaned existing surfaces which become contaminated with rust, dirt, oil, grease, or other contaminants with solvents until thoroughly clean. Steel to be embedded in concrete must be free of dirt and grease prior to embed. Do not paint or galvanize bearing surfaces, including contact surfaces within slip critical joints. Shop coat these surfaces with rust prevention.

2.3.4.2 Pretreatment, Priming and Painting

Apply pre-treatment, primer, and paint in accordance with manufacturer's printed instructions. On surfaces concealed in the finished construction or not accessible for finish painting, apply an additional prime coat to a minimum dry film thickness of 1.0 mil. Tint additional prime coat with a small amount of tinting pigment.

2.3.5 Nonferrous Metal Surfaces

Protect by plating, anodic, or organic coatings.

2.3.6 Aluminum Surfaces

2.3.6.1 Surface Condition

Before finishes are applied, remove roll marks, scratches, rolled-in scratches, kinks, stains, pits, orange peel, die marks, structural streaks, and other defects which will affect uniform appearance of finished surfaces.

2.3.6.2 Aluminum Finishes

Unexposed sheet, plate and extrusions may have mill finish as fabricated. Sandblast castings' finish, medium, AA DAF45. Unless otherwise specified, provide all other aluminum items with a hand sanded or machine finish to a 240 grit. Provide a coating thickness not less than that specified for protective and decorative type finishes for items used in interior locations or architectural Class I type finish for items used in exterior locations. Provide in accordance with AA DAF45. Provide a polished satin finish on items to be anodized.

2.4 DOWNSPOUT TERMINATIONS

Provide cast iron offseet downspout nozzle and flange. sized to fit downspouts and soil pipe of sizes noted. Supply in 12" length. Furnish with factory prime coat.

2.5 MISCELLANEOUS PLATES AND SHAPES

Provide items that do not form a part of the structural steel framework, such as lintels, sill angles, miscellaneous mountings and frames. Provide lintels fabricated from structural steel shapes over openings in masonry walls and partitions as indicated and as required to support wall loads over openings. Provide with connections and fasteners. Construct to have at least 8 in bearing on masonry at each end.

Provide angles and plates in accordance with ASTM A36/A36M, for embedment as indicated. Galvanize embedded items exposed to the elements in accordance with ASTM A123/A123M.

2.6 ROOF HATCHES (SCUTTLES)

Provide aluminum sheets not less than 14 gauge with 3 inch beaded flange, welded and ground at corners. Provide a minimum clear opening of 36 by 36 inches. Insulate cover and curb with one inch thick rigid fiberboard insulation, covered and protected by aluminum sheet of not less than 26 gage. Provide with 12 inches high curb, formed with 3 inch mounting flanges with holes for securing to the roof deck.

2.7 LADDERS

Fabricate vertical ladders conforming to 29 CFR 1910.23 and Section 5 of ALI A14.3. Ladders shall be capable of supporting their maximum intended load. Use 2 1/2 by 3/8 inch steel flats for stringers and 3/4 inch diameter steel rods for rungs. Ladder rungs, step and cleats must be spaced not less than 10 inches and not more than 16 inches wide (measured before installation of ladder safety system), spaced no more than 14 inches apart, plug welded or shouldered and headed into stringers. Install ladders so that the maximum perpendicular distance from the centerline of the steps or rungs, or grab bars, or both, to the nearest permanent object in the back of the ladder or to the finished wall surface will not be less than 7 inches. Provide heavy clip angles riveted or bolted to the stringer and drilled for not less than two 1/2 inch diameter expansion bolts as indicated. Provide intermediate clip angles not over 48 inches on centers. The top rung of the ladder must be level with the top of the access level, parapet or landing served by the ladder except for hatches or wells. Extend the side rails of through or side step ladders 42 inches above the access level. The drawings indicate ladder locations and details of critical dimensions and materials.

2.8 WINDOW SUB-SILL

Provide window sub-sill of extruded aluminum alloy, standard mill finish, of size(s) and design(s) indicated. Provide a minimum of two anchors per window section for securing to mortar joints of masonry sill course. Provide sills with protective coating for shipment, of two coats of a clear, colorless, methacrylate lacquer applied to all surfaces of the sills.

2.9 Steel Pipe Railings:

Standard weight steel pipe with flush fittings and welded joints ground smooth. Install plumb and true to line. Set verticals in metal sleeves, anchor with quick setting cement, installed in strict accordance with manufacturer's instructions, and cover with a setscrew type cover flange.

Sleeves shall be 4 inch deep pipe section reinforced with a #3 x 24 inch hairpin strap and having a 1/8 inch bottom plate. Finish exposed ends with rounded end caps. Where field joints occur, weld a concealed sleeve into one mating section to facilitate alignment before welding. Provide pickets where shown, all joints welded and ground smooth.

Where straight runs over 50-foot long occur, provide a slip-type expansion joint to divide the unbroken run into lengths not exceeding 35 feet.

2.10 Aluminum Pipe Railings

Of 1.25 inch id, Alloy 6063-T6 aluminum handrail pipe with 0.140 inch wall thickness, all-welded assembly with flush fittings, polished to a satin finish. Install plumb and true to line.

Set verticals in pipe sleeves, caulk-in with quick setting anchor cement, and cover sleeve with a setscrew type cover flange. Sleeves shall be 4 inch deep stainless steel pipe 0.5 inch larger than rail, reinforced with a #3 x 24 inch hairpin strap and having a 1/8 inch bottom plate.

Shop coat aluminum to contact anchor cement with lacquer. At wall provide flanges and anchor with expansion bolts unless otherwise detailed. Construct field joints (permitted only where absolutely necessary) with hairline accuracy using a connector sleeve, and secure with countersunk oval head cadmium plated screws on bottom side. Where runs over 50-foot long occur, make provisions for expansion and contraction. Protect material with paper wrapping and do not remove until all work in area has been completed.

PART 3 EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

Install items at locations indicated in accordance with manufacturer's instructions. Verify all field dimensions prior to fabrication. Include materials and parts necessary to complete each assembly, whether indicated or not. Miss-alignment and miss-sizing of holes for fasteners is cause for rejection. Conceal fastenings where practicable. Joints exposed to weather must be watertight.

3.2 WORKMANSHIP

Provide miscellaneous metalwork that is true and accurate in shape, size, and profile. Make angles and lines continuous and straight. Make curves consistent, smooth and unfaceted. Provide continuous welding along the entire area of contact except where tack welding is permitted. Do not tack weld exposed connections. Unless otherwise indicated and approved, provide a smooth finish on exposed surfaces. Provide countersunk rivets where exposed. Provide coped and mitered corner joints aligned flush and without gaps.

3.3 ANCHORAGE, FASTENINGS, AND CONNECTIONS

Provide anchorage as necessary, whether indicated or not, for fastening miscellaneous metal items securely in place. Include slotted inserts, expansion shields, powder-driven fasteners, toggle bolts (when approved for concrete), through bolts for masonry, headed shear studs, machine and carriage bolts for steel, through bolts, lag bolts, and screws for wood. Do not use wood plugs. Provide non-ferrous attachments for non-ferrous metal. Provide exposed fastenings of compatible materials (avoid contact of dissimilar metals), that generally match in color and finish the surfaces to which they are applied. Conceal fastenings where practicable. Provide all fasteners flush with the surfaces they fasten, unless indicated otherwise.

3.4 BUILT-IN WORK

Where necessary and not otherwise indicated, form built-in metal work for anchorage with concrete or masonry. Provide built-in metal work in ample time for securing in place as the work progresses.

3.5 WELDING

Perform welding, welding inspection, and corrective welding in accordance with [AWS D1.1/D1.1M](#). Use continuous welds on all exposed connections. Grind visible welds smooth in the finished installation. Provide welded headed shear studs in accordance with [AWS D1.1/D1.1M](#), Clause 7, except as otherwise specified. Provide in accordance with the safety requirements of [EM 385-1-1](#).

3.6 DISSIMILAR METALS

Where dissimilar metals are in contact, protect surfaces with a coating in accordance with [MPI 79](#) to prevent galvanic or corrosive action. Where aluminum is in contact with concrete, plaster, mortar, masonry, wood, or absorptive materials subject to wetting, protect in accordance with [ASTM D1187/D1187M](#), asphalt-base emulsion. Clean surfaces with metal shavings from installation at the end of each work day.

3.7 PREPARATION

3.7.1 Material Coatings and Surfaces

Remove rust preventive coating just prior to field erection, using a remover approved by the metal manufacturer. Surfaces, when assembled, must be free of rust, grease, dirt and other foreign matter.

3.7.2 Environmental Conditions

Do not clean or paint surfaces when damp or exposed to foggy or rainy weather, when metallic surface temperature is less than minus 5 degrees F above the dew point of the surrounding air, or when surface temperature is below 45 degrees F or over 95 degrees F, unless approved by the Contracting Officer. Metal surfaces to be painted must be dry for a minimum of 48 hours prior to the application of primer or paint.

3.8 ROOF HATCH (SCUTTLES)

Construction and accessories as follows:

- a. Provide insulated cover and curb with mounting flanges for securing to roof deck. Provide curbs with integral metal cap flashing of the same gage and metal as the curb, fully welded and ground at corners for weather tightness.
- b. Provide hatches completely assembled, with pintle hinges, compression spring operators enclosed in telescopic tubes, positive snap latches with turn handles on inside and outside, and neoprene draft seals. Provide fasteners for padlocking from the inside. Provide covers with automatic hold-open arms complete with grip handle to permit one hand release. Cover action must be smooth through its entire range of motion with an operating pressure of approximately 30 pounds.

3.9 LADDERS

Secure to the adjacent construction with the clip angles attached to the stringer. Install brackets as required for securing of ladders welded or bolted to roof and attic structure.

3.10 INSTALLATION OF DOWNSPOUT TERMINATIONS

Secure downspouts terminations to downspouts and substrate per manufacturer's instructions.

3.11 INSTALLATION MISCELLANEOUS PLATES AND SHAPES

Provide lintels fabricated from structural steel shapes over openings in masonry walls and partitions as indicated and as required to support wall loads over openings. Provide with connections and fasteners. Construct to have at least 8 inches bearing on masonry at each end.

-- End of Section --

SECTION 06 10 00

ROUGH CARPENTRY
08/16, CHG 2: 11/18

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN INSTITUTE OF TIMBER CONSTRUCTION (AITC)

AITC TCM (2012) Timber Construction Manual, 5th Edition

AMERICAN LUMBER STANDARDS COMMITTEE (ALSC)

ALSC PS 20 (2015) American Softwood Lumber Standard

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B18.2.1 (2012; Errata 2013) Square and Hex Bolts and Screws (Inch Series)

ASME B18.2.2 (2022) Nuts for General Applications: Machine Screw Nuts, and Hex, Square, Hex Flange, and Coupling Nuts (Inch Series)

ASME B18.5.2.1M (2006; R 2011) Metric Round Head Short Square Neck Bolts

ASME B18.5.2.2M (1982; R 2010) Metric Round Head Square Neck Bolts

ASME B18.6.1 (2016) Wood Screws (Inch Series)

AMERICAN WOOD COUNCIL (AWC)

AWC NDS (2015) National Design Specification (NDS) for Wood Construction

AWC WFCM (2012) Wood Frame Construction Manual for One- and Two-Family Dwellings

AMERICAN WOOD PROTECTION ASSOCIATION (AWPA)

AWPA M2 (2019) Standard for the Inspection of Preservative Treated Wood Products for Industrial Use

AWPA M6 (2013) Brands Used on Preservative Treated Materials

APA - THE ENGINEERED WOOD ASSOCIATION (APA)

APA E30	(2016) Engineered Wood Construction Guide
APA E445	(2002) Performance Standards and Qualification Policy for Structural-Use Panels (APA PRP-108)
APA F405	(19) Product Guide: Performance Rated Panels
APA L870	(2010) Voluntary Product Standard, PS 1-09, Structural Plywood
APA S350	(2014) PS 2-10, Performance Standard for Wood-Based Structural-Use Panels

ASTM INTERNATIONAL (ASTM)

ASTM A153/A153M	(2016a) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A307	(2021) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM C1177/C1177M	(2017) Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing
ASTM D2898	(2010; R 2017) Standard Practice for Accelerated Weathering of Fire-Retardant-Treated Wood for Fire Testing
ASTM D3498	(2019a) Standard Specification for Adhesives for Field-Gluing Wood Structural Panels (Plywood or Oriented Strand Board) to Wood Based Floor System Framing
ASTM F547	(202) Standard Terminology of Nails for Use with Wood and Wood-Base Materials
ASTM F1667/F1667M	(2021a) Standard Specification for Driven Fasteners: Nails, Spikes, and Staples

INTERNATIONAL CODE COUNCIL (ICC)

ICC IBC	(2021) International Building Code

TRUSS PLATE INSTITUTE (TPI)

TPI 1	(2014) National Design Standard for Metal Plate Connected Wood Truss Construction, Including Commentary and Appendices
TPI HIB	(1991) Commentary and Recommendations for Handling, Installing and Bracing Metal Plate Connected Wood Trusses

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FS UU-B-790

(Rev A; Notice 2) Building Paper Vegetable
Fiber: (Kraft, Waterproofed, Water
Repellent and Fire Resistant)

1.2 SUBMITTALS

Government approval is required for submittals . Submit the following in
accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Modifications of Structural Members

Drawings of structural fabricated wood trusses, and other
fabricated structural members indicating materials, shop
fabrication, and field erection details; including methods of
fastening.

Nailers and Nailing Strips

Drawings of field erection details, including materials and
methods of fastening nailers in conformance with Factory Mutual
wind uplift rated systems specified in other Sections of these
specifications.

Fabricated Structural Members

Prefabricated Wood Trusses

SD-03 Product Data

Fire-retardant Treatment

Adhesives

SD-05 Design Data

Modifications of Structural Members

Design analysis and calculations showing design criteria used to
accomplish the applicable analysis.

SD-06 Test Reports

Preservative-treated Lumber and Plywood

SD-07 Certificates

Preservative Treatment

1.3 DELIVERY AND STORAGE

Deliver materials to the site in an undamaged condition. Store, protect,
handle, and install prefabricated structural elements in accordance with
manufacturer's instructions and as specified. Store materials off the
ground to provide proper ventilation, with drainage to avoid standing

water, and protection against ground moisture and dampness. Store materials with a moisture barrier at both the ground level and as a cover forming a well ventilated enclosure. Store wood I-beams and glue-laminated beams and joists on edge. Adhere to requirements for stacking, lifting, bracing, cutting, notching, and special fastening requirements. Do not use materials that have visible moisture or biological growth. Remove defective and damaged materials and provide new materials. Store separated reusable wood waste convenient to cutting station and area of work.

1.4 GRADING AND MARKING

1.4.1 Lumber

Mark each piece of framing and board lumber or each bundle of small pieces of lumber with the grade mark of a recognized association or independent inspection agency. Such association or agency must be certified by the Board of Review, American Lumber Standards Committee, to grade the species used. Surfaces that are to be exposed to view must not bear grademarks, stamps, or any type of identifying mark. Hammer marking will be permitted on timbers when all surfaces will be exposed to view.

1.4.2 Plywood

Mark each sheet with the mark of a recognized association or independent inspection agency that maintains continuing control over the quality of the plywood. The mark must identify the plywood by species group or span rating, exposure durability classification, grade, and compliance with [APA L870](#). Surfaces that are to be exposed to view must not bear grademarks or other types of identifying marks.

1.4.3 [Preservative-Treated](#) Lumber and Plywood

The Contractor is responsible for the quality of treated wood products. Each treated piece must be inspected in accordance with [AWPA M2](#) and permanently marked or branded, by the producer, in accordance with [AWPA M6](#). The Contractor must provide Contracting Officer's Representative (COR) with the inspection report of an approved independent inspection agency that offered products comply with applicable AWP Standards. The appropriate Quality Mark on each piece will be accepted, in lieu of inspection reports, as evidence of compliance with applicable AWP treatment standards.

1.4.4 Fire-Retardant Treated Lumber

Mark each piece in accordance with [AWPA M6](#), except pieces that are to be natural or transparent finished. In addition, exterior fire-retardant lumber must be distinguished by a permanent penetrating blue stain. Labels of a nationally recognized independent testing agency will be accepted as evidence of conformance to the fire-retardant requirements of [AWPA M6](#).

1.4.5 Hardboard, Gypsum Board, and Fiberboard

Mark each sheet or bundle to identify the standard under which the material is produced and the producer.

1.5 SIZES AND SURFACING

ALSC PS 20 for dressed sizes of yard and structural lumber. Lumber must be surfaced four sides. Size references, unless otherwise specified, are nominal sizes, and actual sizes must be within manufacturing tolerances allowed by the standard under which the product is produced. Other measurements are IP or SI standard.

1.6 MOISTURE CONTENT

Air-dry or kiln-dry lumber. Kiln-dry treated lumber after treatment. Maximum moisture content of wood products must be as follows at the time of delivery to the job site:

- a. Framing lumber and board, 19 percent maximum
- b. Timbers **5 inches** and thicker, 25 percent maximum
- c. Materials other than lumber; moisture content must be in accordance with standard under which the product is produced

1.7 PRESERVATIVE TREATMENT

- a. **0.25 pcf** intended for above ground use.
- b. **0.40 pcf** intended for ground contact and fresh water use. **0.60 pcf** intended for Ammoniacal Copper Quaternary Compound (ACQ)-treated foundations. **0.80 to 1.00 pcf** intended for ACQ-treated pilings. All wood must be air or kiln dried after treatment. Specific treatments must be verified by the report of an approved independent inspection agency, or the AWP Quality Mark on each piece. Do not incise surfaces of lumber that will be exposed. Brush coat areas that are cut or drilled after treatment with either the same preservative used in the treatment or with a 2 percent copper naphthenate solution. The following items must be preservative treated:
 - (1) Wood framing, woodwork, and plywood up to and including the subflooring at the first-floor level of structures having crawl spaces when the bottoms of such items are **24 inches** or less from the earth underneath.
 - (2) Wood members that are in contact with water.
 - (3) Exterior wood steps, platforms, and railings; and all wood framing of open, roofed structures.
 - (4) Wood sills, soles, plates, furring, and sleepers that are less than **24 inches** from the ground, furring and nailers that are set into or in contact with concrete or masonry.
 - (5) Nailers, edge strips, crickets, curbs, and cants for roof decks.

1.8 FIRE-RETARDANT TREATMENT

Fire-retardant treated wood must be pressure treated Treatment and performance inspection must be by an independent and qualified testing agency that establishes performance ratings. Each piece or bundle of treated material must bear identification of the testing agency to indicate performance in accordance with such rating. Treated materials to

be exposed to rain wetting must be subjected to an accelerated weathering technique in accordance with **ASTM D2898** prior to being tested. Such items which will not be inside a building, and such items which will be exposed to heat or high humidity, must receive exterior fire-retardant treatment. Fire-retardant-treated wood products must be free of halogens, sulfates, ammonium phosphate, and formaldehyde.

1.9 QUALITY ASSURANCE

1.9.1 Drawing Requirements

For **fabricated structural members**, trusses, indicate materials, details of construction, methods of fastening, and erection details. Include reference to design criteria used and manufacturers design calculations. Submit drawings for all proposed modifications of structural members. Do not proceed with modifications until the submittal has been approved.

1.9.2 Data Required

Submit calculations and drawings for all proposed **modifications of structural members**. Do not proceed with modifications until the submittal has been approved.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Virgin Lumber

Lumber fabricated from old growth timber is not permitted. Avoid companies who buy, sell, or use old growth timber in their operations, when possible.

2.2 LUMBER

2.2.1 Structural Lumber

Structural lumber shall be of stress grade and quality required but not less than SPIB Structural #2 Any of the species and grades listed in **AWC NDS**. Use for joists, rafters, headers, trusses, beams (except collar beams), columns, posts, stair stringers, girders, and all other members indicated to be stress rated. Design of members and fastenings must conform to **AITC TCM**. Other stress graded or dimensioned items such as blocking, carriages, and studs must be standard or No. 2 grade except that studs may be Stud grade.

2.2.2 Framing Lumber

Framing lumber such as studs, plates, caps, collar beams, cant strips, bucks, sleepers, **nailing strips**, and nailers and board lumber such as subflooring and wall and roof sheathing must be **of live, sound stock, S4S, thoroughly seasoned and air or kiln dried to a maximum moisture content of 15 percent**. Cull or cut out any defect-causing member to be unsuitable for use intended.

2.3 PLYWOOD, STRUCTURAL-USE PANELS

APA L870, APA S350, APA E445, and APA F405 respectively.

2.3.1 Subflooring

2.3.1.1 Plywood

C-D Grade, Exposure 1 durability classification, Span rating of 24/16 or greater.

2.3.2 Wall Sheathing

2.3.2.1 Wall Sheathing on CMU

Fiberglass faced gypsum sheathing; 1/2 inch thick x 4 feet wide sheets, meeting ASTM C1177/C1177M, with water resistance core and water repellent paper facing. Secure with masonry galvanized screws 6" oc along edges, 8" oc panel field.

2.3.3 Roof Sheathing

2.3.3.1 Roof Sheathing

APA grade CDX-INT plywood with exterior glue, 3/4 inch thick and having span index equal to spans to be encountered; where exposed to weather at overhang or elsewhere to be A-C EXT grade or better. Install with face grain across supports, with 1/8 inch end and side space; each panel must be continuous across two or more spans. End joints staggered over alternate bearing. Nail 6 inches oc along edges, and 12 inches oc along intermediate supports, using 8d cement coated Ring Shank nails 2.5 inches in length. Protect eave and rake edges with lumber starter strips.

Where span exceeds 20 inches, provide edge support with panel clips.

2.4 OTHER MATERIALS

2.4.1 Building Paper

FS UU-B-790, Type I, Grade D, Style 1.

2.4.2 PREFABRICATED WOOD TRUSSES

2.4.2.1 Trusses

Prefabricated wood trusses (metal plate connected) designed and fabricated in accordance with applicable codes, with TPI 1 and TPI HIB and fabricated in accordance with TPI 1AITC and the Truss Plate Institute (except as specifically noted otherwise). Provide double trusses, additional bracing or other modifications as required for support of special loads or unusual conditions.

Lumber shall be of stress grade and quality required but not less than SPIB Structural #2 and C-C Structural 1 grade plywood. Chord members shall be 2 x 6 minimum. Interior web configuration is manufacturer's option. Coordinate web arrangement and truss spacing with mechanical and other affected areas. Verify dimensions and details shown and notify Architect of any required modifications.

Truss manufacturer shall provide all necessary truss-to-truss connectors, headers and eave extensions. Gable outlookers, valley rafters and anchors to the plate line are specified elsewhere in this Section.

Bridging and bracing shall be designed and adequately delineated by the truss manufacturer's engineer shall be furnished and installed by the Contractor's forces.

2.4.2.2 Design Responsibility:

Design responsibility for strength and stability of the trusses and the truss system above the plate line lies with the truss supplier. Submission of a bid shall signify acceptance of that responsibility.

Design of trusses and all permanent web bracing, truss bridging and truss anchors shall be performed by the truss design engineer, who shall be a structural engineer registered in the State of Alabama. This engineer shall examine the project drawings to ascertain deck and ceiling details, special loads, necessary framed openings between and thru trusses, roof deck openings larger than the typical space between trusses, etc., and provide details coordinated with his truss design. Restamping of another engineer's design sheets by an Alabama registered engineer does not meet these requirements.

2.4.2.3 Bridging and Bracing

Size, grade, attachment and location of all permanent lateral bridging and bracing required to stabilize web and chord members against out-of-plane buckling shall be shown on truss layout and erection plan furnished by truss supplier. This shall also include location and termination points of diagonal and lateral braces required to stabilize the truss system.

Bridging and bracing meeting the truss designer's criteria may be supplied by either the truss manufacturer or the Contractor.

2.4.3 Miscellaneous Wood Members

2.4.3.1 PLATES, NAILERS, BLOCKING, ETC.

- a. Material: S4S-SYP, sizes as shown, #2 Structural Grade and Standard Grade Light Framing members, or better.
- b. Continuous Wood Nailers: Provide as shown or required. Install straight and true to line, well fitted and secured in place. Secure with bolts as shown or required by application.
- c. Wood Blocking: As shown on plans or required to facilitate construction. Provide blocking (2 x 6 min. size) to facilitate attachment of door bumpers, millwork, toilet accessories, equipment, toilet partitions, etc.

2.4.4 Adhesives

Comply with applicable regulations regarding toxic and hazardous materials and as specified.

2.5 ROUGH HARDWARE

Unless otherwise indicated or specified, rough hardware must be of the type and size necessary for the project requirements. Sizes, types, and spacing of fastenings of manufactured building materials must be as recommended by the product manufacturer unless otherwise indicated or specified. Rough hardware exposed to the weather or embedded in or in contact with preservative treated wood, exterior masonry, or concrete walls or slabs must be hot-dip zinc-coated in accordance with [ASTM A153/A153M](#). Nails and fastenings for fire-retardant treated lumber and woodwork exposed to the weather must be copper alloy or hot-dipped

galvanized fasteners as recommended by the treated wood manufacturer.

2.5.1 Bolts, Nuts, Studs, and Rivets

ASME B18.2.1, ASME B18.5.2.1M, ASME B18.5.2.2M and ASME B18.2.2.

2.5.2 Anchor Bolts

ASTM A307, size as indicated, complete with nuts and washers.

2.5.3 Lag Screws and Lag Bolts

ASME B18.2.1.

2.5.4 Wood Screws

ASME B18.6.1.

2.5.5 Nails

ASTM F547, size and type best suited for purpose. For sheathing and subflooring, length of nails must be sufficient to extend 1 inch into supports. In general, 8-penny or larger nails must be used for nailing through 1 inch thick lumber and for toe nailing 2 inch thick lumber; 16-penny or larger nails must be used for nailing through 2 inch thick lumber. Nails used with treated lumber and sheathing must be hot-dipped galvanized in accordance with ASTM A153/A153M. Nailing must be in accordance with the recommended nailing schedule contained in AWC WFCM. Where detailed nailing requirements are not specified, nail size and spacing must be sufficient to develop an adequate strength for the connection. The connection's strength must be verified against the nail capacity tables in AWC NDS. Reasonable judgment backed by experience must ensure that the designed connection will not cause the wood to split. If a load situation exceeds a reasonable limit for nails, a specialized connector must be used.

2.5.6 Wire Nails

ASTM F1667/F1667M.

2.5.7 Clip Angles

Steel, 3/16 inch thick, size as indicated; or zinc-coated steel or iron commercial clips designed for connecting wood members.

2.5.8 Joist Hangers

Steel or iron, zinc coated, sized to fit the supported member, of sufficient strength to develop the full strength of the supported member in accordance with ICC IBC, and furnished complete with any special nails required.

2.5.9 Tie Straps

For joists supported by the lower flange of steel beams, provide 1/8 by 1-1/2 inch steel strap, 2 feet long, except as indicated otherwise.

2.5.10 Joist Anchors

For joists supported by masonry walls, provide anchors $3/16$ by $1\ 1/2$ inch steel tee or strap, bent and of length to provide 4 inches embedment into wall and 12 inches along joist except as indicated otherwise. For joists parallel to masonry or concrete walls, provide anchors $1/4$ by $1-1/4$ inch minimum cross-sectional area, steel strap, length as necessary to extend over top of first three joists and into wall 8 inches, and with wall end of bend or pin type, except as indicated otherwise.

2.5.11 Door Buck Anchors

Metal anchors, $1/8$ by $1-1/4$ inch steel, 12 inches long, with ends bent 2 inches, except as indicated otherwise. Anchors must be screwed to the backs of bucks and built into masonry or concrete. Locate 8 inches above sills and below heads and not more than 24 inches intermediately between.

2.5.12 Panel Edge Clips

Extruded aluminum or galvanized steel, H-shaped clips to prevent differential deflection of roof sheathing.

PART 3 EXECUTION

3.1 INSTALLATION

Do not install building construction materials that show visual evidence of biological growth.

Conform to AWC WFCM unless otherwise indicated or specified. Select lumber sizes to minimize waste. Fit framing lumber and other rough carpentry, set accurately to the required lines and levels, and secure in place in a rigid manner. Do not splice framing members between bearing points. Set joists, rafters, and purlins with their crown edge up. Frame members for the passage of pipes, conduits, and ducts. Do not cut or bore structural members for the passage of ducts or pipes without approval. Reinforce all members damaged by such cutting or boring by means of specially formed and approved sheet metal or bar steel shapes, or remove and provide new, as approved. Provide as necessary for the proper completion of the work all framing members not indicated or specified. Spiking and nailing not indicated or specified otherwise must be in accordance with the Nailing Schedule contained in ICC IBC; perform bolting in an approved manner. Spikes, nails, and bolts must be drawn up tight. Provide 2 inch minimum clearance between cooking exhaust and wood framing. Fill the spaces with strips of approved noncombustible material. Use slate or steel shims when leveling joists, beams, and girders on masonry or concrete. Do not use shimming on wood or metal bearings. When joists, beams, and girders are placed on masonry or concrete, a wood base plate must be positioned and leveled with grout. The joist, beam, or girder must then be placed on the plate. When joists, beams, and girders are set into masonry or concrete, a pocket must be formed into the wall. The joist, beam, or girder must then be placed into the pocket and leveled with a steel shim.

3.1.1 Roof Framing or Rafters

Tops of supports or rafters must form a true plane. Valley, ridge, and hip members must be of depth equal to cut on rafters where practicable, but in no case less than depth of rafters and nominally 2 inches thick.

Rafters must be notched and have full and solid bearing on plates. Valleys, hips, and ridges must be straight and true intersections of roof planes. Necessary crickets and watersheds must be formed. Rafters, except hip and valley rafters, must be bolted by angles. Rafters must be toe-nailed to ridge, valley, or hip members with at least three 8-penny nails. Rafters must be braced to prevent movement until permanent bracing, decking or sheathing is installed. Hip and valley rafters must be secured to wall plates by clip angles. Openings in roof must be framed with headers and trimmers. Unless otherwise indicated, headers carrying more than two rafters and trimmers supporting headers carrying more than one rafter must be double. Hip rafters longer than the available lumber must be butt jointed and scabbed. Valley rafters longer than the available lumber must be double, with pieces lapped not less than 4 feet and well spiked together. Install trussed rafters in accordance with TPI HIB. Install engineered wood joists in accordance with distributor's instructions.

3.1.2 Subflooring

3.1.2.1 Plywood Panels

Apply best side up with the grain of outer plies or the long dimension at right angles to joists. Stagger end joints and locate over the centerline of joists. Support panel edges as indicated. Allow 1/8 inch spacing at panel ends and 1/4 inch at panel edges. Panels must be continuous over two or more spans. Nail panels 6 inches o.c. at supported edges and 10 inches o.c. over intermediate bearing. Nails must be 8-penny common or 6-penny threaded. Provide at least 1/2 inch clearance between subflooring and masonry or concrete walls. Subflooring may be installed with adhesive conforming to ASTM D3498 and nails spaced at 12 inches on center unless otherwise shown.

3.1.3 Wall Sheathing

3.1.3.1 Gypsum Sheathing Board

Apply gypsum sheathing board either horizontally or vertically. Butt joints and locate over the centerlines of supports. Horizontally applied sheathing must be T&G, applied with tongued edge up. Stagger vertical joints and abut sheet closely to frames of openings. Secure with masonry galvanized screws 6" oc along edges, 8" oc panel field

3.1.4 Trusses

Metal plate connected wood trusses must be handled, erected, and braced in accordance with TPI HIB and as indicated. Erection bracing is the responsibility of the Contractor.

3.1.5 Plywood Panel Roof Sheathing

Install with the grain of the outer plies or long dimension at right angles to supports. Stagger end joints and locate over the centerlines of supports. Allow 1/8 inch spacing at panel ends and 1/4 inch at panel edges. Nail panels with 8-penny common nails or 6-penny annular rings or screw-type nails spaced 6 inches o.c. at supported edges and 12 inches o.c. at intermediate bearings. Do not use staples in roof sheathing. Where the support spacing exceeds the maximum span for an unsupported edge, provide adequate blocking, tongue-and-groove edges, or panel edge clips, in accordance with APA E30.

3.2 MISCELLANEOUS

3.2.1 Wood Roof Nailers, Edge Strips, Crickets, Curbs, and Cants

Provide sizes and configurations indicated or specified and anchored securely to continuous construction.

3.2.2 Rough Wood Bucks

Size as indicated. Set wood bucks true and plumb. Anchor bucks to concrete or masonry with steel straps extending into the wall **8 inches** minimum. Place anchors near the top and bottom of the buck and space uniformly at **2 foot** maximum intervals.

3.2.3 Wood Blocking

Provide proper sizes and shapes at proper locations for the installation and attachment of wood and other finish materials, fixtures, equipment, and items indicated or specified.

3.2.4 Wood Grounds

Provide for fastening wood trim, finish materials, and other items to plastered walls and ceilings. Install grounds in proper alignment and true with an **8 foot** straightedge.

3.2.5 Wood Furring

Provide where shown and as necessary for facing materials specified. Except as shown otherwise, furring strips must be nominal one by 3, continuous, and spaced **16 inches** o.c. Erect furring vertically or horizontally as necessary. Nail furring strips to masonry. Do not use wood plugs. Provide furring strips around openings, behind bases, and at angles and corners. Furring must be plumb, rigid, and level and must be shimmed as necessary to provide a true, even plane with surfaces suitable to receive the finish required. Form furring for cornices, offsets and breaks in walls or ceilings on 1 by 4 wood strips spaced **16 inches** o.c.

3.2.6 Temporary Closures

Provide with hinged doors and padlocks and install during construction at exterior doorways and other ground level openings that are not otherwise closed. Cover windows and other unprotected openings with polyethylene or other approved material, stretched on wood frames. Provide dustproof barrier partitions to isolate areas as directed.

3.2.7 Temporary Centering, Bracing, and Shoring

Provide for the support and protection of masonry work during construction as specified in Section **04 20 00**. Forms and centering for cast-in-place concrete work are specified in Section **03 30 00** CAST-IN-PLACE CONCRETE.

3.2.8 Bridging

Wood bridging must have ends accurately bevel-cut to afford firm contact and must be nailed at each end with two nails. Install metal bridging as recommended by the manufacturer. The lower ends of bridging must be driven up tight and secured after subflooring or roof sheathing has been

laid and partition framing installed.

3.3 WASTE MANAGEMENT OF WOOD PRODUCTS

In accordance with the Waste Management Plan and as specified. Separate and reuse scrap sheet materials larger than 2 square feet, framing members larger than 16 inches, and multiple offcuts of any size larger than 12 inches. Clearly separate damaged wood and other scrap lumber for acceptable alternative uses on site, including bracing, blocking, cripples, ties, and shims.

Separate treated, stained, painted, and contaminated wood and place in designated area for hazardous materials. Dispose of according to local regulations. Do not leave any wood, shavings, sawdust, or other wood waste buried in fill or on the ground. Prevent sawdust and wood shavings from entering the storm drainage system. Do not burn scrap lumber that has been pressure treated, or lumber that is less than one year old.

-- End of Section --

SECTION 06 20 00

FINISH CARPENTRY
08/16, CHG 2: 11/18

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN LUMBER STANDARDS COMMITTEE (ALSC)

ALSC PS 20 (2015) American Softwood Lumber Standard

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B18.2.1 (2012; Errata 2013) Square and Hex Bolts and Screws (Inch Series)

ASME B18.2.2 (2022) Nuts for General Applications: Machine Screw Nuts, and Hex, Square, Hex Flange, and Coupling Nuts (Inch Series)

ASME B18.6.1 (2016) Wood Screws (Inch Series)

AMERICAN WOOD PROTECTION ASSOCIATION (AWPA)

AWPA M4 (2021) Standard for the Care of Preservative-Treated Wood Products

AWPA U1 (2022) Use Category System: User Specification for Treated Wood

APA - THE ENGINEERED WOOD ASSOCIATION (APA)

APA L870 (2010) Voluntary Product Standard, PS 1-09, Structural Plywood

ASTM INTERNATIONAL (ASTM)

ASTM F547 (202) Standard Terminology of Nails for Use with Wood and Wood-Base Materials

BUILDERS HARDWARE MANUFACTURERS ASSOCIATION (BHMA)

ANSI/BHMA A156.9 (2020) Cabinet Hardware

CALIFORNIA AIR RESOURCES BOARD (CARB)

CARB 93120 (2007) Airborne Toxic Control Measure (ATCM) to Reduce Formaldehyde Emissions from Composite Wood Products

CALIFORNIA DEPARTMENT OF PUBLIC HEALTH (CDPH)

CDPH SECTION 01350 (2010; Version 1.1) Standard Method for
the Testing and Evaluation of Volatile
Organic Chemical Emissions from Indoor
Sources using Environmental Chambers

GREEN SEAL (GS)

GS-36 (2013) Adhesives for Commercial Use

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI/NEMA LD 3 (2005) Standard for High-Pressure
Decorative Laminates

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT (SCAQMD)

SCAQMD Rule 1168 (2017) Adhesive and Sealant Applications

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

40 CFR 770 Formaldehyde Standards for Composite Wood
Products

UNDERWRITERS LABORATORIES (UL)

UL 2818 (2013) GREENGUARD Certification Program
For Chemical Emissions For Building
Materials, Finishes And Furnishings

WINDOW AND DOOR MANUFACTURERS ASSOCIATION (WDMA)

WDMA I.S.4 (2015A) Preservative Treatment for Millwork

WOOD MOULDING AND MILLWORK PRODUCERS ASSOCIATION (WMMPA)

WMMPA WM 6 (2007) Quality Industry Standards Booklet

WOODWORK INSTITUTE (WI)

NAAWS 3.1 (2017; 2018 Errata Edition) North American
Architectural Woodwork Standards

1.2 SUBMITTALS

Government approval is required for submittals. Submit the following in
accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Detail Drawings Indicating All Wood Assemblies;

Cabinet Work

SD-03 Product Data

Wood Products

Countertops

Treated Wood Products

Fascias and Trim

Hardware and Accessories

Plastic Laminates

Quartz Agglomerate Material

Quartz Counter Tops

SD-04 Samples

Plastic Laminates

Samples

SD-07 Certificates

Certificates of Grade

Indoor Air Quality for Non-aerosol Adhesives

Indoor Air Quality for Aerosol Adhesives

Indoor Air Quality For Solid Surface Fabrication Products

1.3 DETAIL DRAWINGS

Submit detail drawings indicating all wood assemblies proposed for use in the project. Indicate materials, species, grade, density, grain, finish details of construction, location of use in the project, finishes, types, method and arrangement of fasteners, and installation details. This includes all fabricated assemblies.

1.4 PRODUCT DATA

Submit Manufacturers printed data including proposed species, grade, density grain, and finish as applicable; sufficient to demonstrate compliance with this specification for each type of wood product specified. For treated wood products also provide documentation of environmentally safe preservatives for each type of wood product specified.

Provide Manufacturers printed data for hardware and all wood accessories including but not limited to edge banding, adhesives, and sealers.

1.5 SAMPLES

After approval of shop drawing fabricate one representative section each of base, wall and wardrobe type cabinets and deliver to site for approval. Upon approval, units may be incorporated in work. Samples shall indicate proposed species, grade, density grain, and finish for each type of wood product and finish specified or indicated.

1.6 DELIVERY, STORAGE, AND HANDLING

Deliver wood products to the jobsite in an undamaged condition. Stack materials to ensure ventilation and drainage. Protect against dampness before and after delivery. Store materials under cover in a well ventilated enclosure and protect against extreme changes in temperature and humidity. Keep materials wrapped and separated from off-gassing materials (such as drying paints and adhesives). Do not use materials that have visible moisture or biological growth. Do not store products in building until wet trade materials are dry and humidity of the space is within wood manufacturer's tolerance limits for storage.

1.7 QUALITY ASSURANCE

1.7.1 Certifications

1.7.1.1 Certified Wood Grades

Provide [certificates of grade](#) from the grading agency on graded but unmarked lumber or plywood attesting that materials meet the grade requirements specified herein.

1.7.1.2 Indoor Air Quality Certifications

1.7.1.2.1 Adhesives and Sealants

Provide products certified to meet indoor air quality requirements by [UL 2818](#) (Greenguard) Gold, SCS Global Services Indoor Advantage Gold or provide certification or validation by other third-party programs that products meet the requirements of this Section. Provide current product certification documentation from certification body. When product does not have certification, provide validation that product meets the indoor air quality product requirements cited herein.

1.7.1.2.2 Composite Wood Products

For purposes of this specification, composite wood products include hardwood plywood, particleboard, medium density fiberboard (MDF), panel substrates, and door cores. Provide products certified to meet requirements of both [40 CFR 770](#) and [CARB 93120](#). Provide current product certification documentation from certification body.

1.7.2 Lumber

Identify each piece or each bundle of lumber, millwork, and trim by the grade mark of a recognized association or independent inspection agency certified by the Board of Review of the ALSC to grade the species.

1.7.3 Plywood

Provide each sheet of plywood with the mark of a recognized association or independent inspection agency that maintains continuing control over the quality of the plywood. Marks must identify plywood by species group or span rating, exposure durability classification, grade, and compliance with [APA L870](#).

1.7.4 Pressure Treated Lumber and Plywood

Inspect each treated piece in accordance with [AWPA U1](#).

1.7.5 Non-Pressure Treated Woodwork and Millwork

Mark, stamp, or label to indicate compliance with **WDMA I.S.4**.

1.7.6 General Workmanship

In accordance with details and best shop practice. Set partitions, ends, panels, etc. with face grain vertical. Fill and machine sand all exposed plywood edges.

Neatly fit trim work together, with finish surfaces scribed and jointed without exposed defects. Provide adequate equipment at site including bench saw, jointer and sander. Bring interior finish materials into building only after openings are closed and plaster is dry.

Fabricate cabinets with minimum practical construction joints; arrange joints so that face appearance of work is not altered. Field apply tops, finish base, and splash strips in maximum lengths w/joints offset from joints in cabinet units. Scribe top and splash members so that scribe molds are not required.

All material brought to job site shall be free of saw, jointer and planer marks and shall be sanded until smooth with slightly rounded edges. Should such blemishes be found after material is in place and finished, it shall be taken down and returned to the fabricator for reworking and/or replacement.

Nail thoroughly, from both directions where members with shoulder type joints or intersections occur. Set nail heads ready for finishing. Supplement with glue blocks where good practice requires. Glue and nail, panels into frame assemblies.

PART 2 PRODUCTS

2.1 WOOD PRODUCTS

2.1.1 Sizes and Patterns of Wood Products

Provide yard and board lumber sizes in accordance with **ALSC PS 20**. Provide shaped lumber and millwork in the patterns indicated and in standard patterns of the association covering the species. Size references, unless otherwise specified, are nominal sizes. Provide actual sizes within manufacturing tolerances allowed by the applicable standard.

2.1.2 Species and Grades

Provide in accordance with **AWPA U1** Use Category System Tables unless otherwise specified herein.

2.1.3 Trim, Finish, and Frames

Provide species and grades listed in the table below for wood materials that must be painted. For materials that must be stained, have a natural, or a transparent finish, provide materials one grade higher than those listed in the table below. Provide trim, except window stools and aprons with hollow backs.

2.1.3.1 Typical Wood Materials for Trim and Cabinets:

- a. Heavy framing members - AWI custom grade fir or poplar
- b. Tops - AB plywood (Exterior grade AC where sinks occur)
- c. Splash - Particle board (1 inch where full height occurs)
- d. Panels - 9 ply A2 grade plywood, hardwood veneered
- e. Backs and bottoms - Grade AB plywood (backs 1/4 inch masonite where noted)
- f. Shelves - Grade AA plywood (same as doors where exposed); Use 1 inch thick plywood on shelves greater than 42 inches wide.
- g. Ends, partitions, drawer bottoms - Grade AB plywood
- h. Face pieces - select fir or white pine
- i. Ends and verticals - Grade AB plywood (same as doors where exposed).

Note: **

<http://www.nelma.org/library/2013-standard-grading-rules-for-northeastern-lumber/>

2.1.4 Softwood Plywood

Provide in accordance with **APA L870**. When located on the interior of buildings, provide products with no added urea-formaldehyde resins.

- a. Plywood for Soffits: Exterior type, B-B medium density overlay.
- b. Plywood for Shelving: Interior type, A-B Grade, any species group.
- c. Plywood for Countertops: Exterior type, A-C Grade.

2.1.5 Shoe Mould

Clear red or white oak, 1/2 by 5/8 inch unless otherwise indicated.

2.2 FASCIAS AND TRIM

2.2.1 Wood

Provide species and grades for all fascia and trim, including exterior door and window casings, in accordance with **AWPA U1** Use Category System Tables. Provide sizes indicated. Metal corners may be provided in lieu of wood corner boards for horizontal siding. If metal corners are used, provide galvanized steel or aluminum, completely coated with primer compatible for the specific metal substrate.

2.3 CABINET WORK

2.3.1 High Pressure Decorative Laminate (HPDL)

Provide plastic laminates meeting the requirements of ANSI/NEMA LD 3 and ANSI A161.2 for high-pressure decorative laminates. Design, colors, surface finish and texture, and locations are indicated on the drawings. Submit two samples of each plastic laminate pattern and color. Samples less than 5 by 7 inches in size are not acceptable. Provide plastic

laminate types and nominal minimum thicknesses for casework components as indicated in the following paragraphs.

2.3.2 Horizontal General Purpose Standard (HGS) Grade

Provide horizontal general purpose standard grade plastic laminate that is 0.048 inches (plus or minus 0.005 inches) in thickness. This laminate grade is intended for horizontal surfaces where postforming is not required.

2.3.3 Vertical General Purpose Standard (VGS) Grade

Provide vertical general purpose standard grade plastic laminate that is 0.028 inches (plus or minus 0.004 inches) in thickness. This laminate grade is intended for exposed exterior vertical surfaces of casework components where postforming is not required.

2.3.4 Cabinet Liner Standard (CLS) Grade

Provide cabinet liner standard grade plastic laminate that is 0.020 inches in thickness. This laminate grade is intended for light duty semi-exposed interior surfaces of casework components.

2.3.5 Backing Sheet (BK) Grade

Undecorated backing sheet grade laminate is formulated specifically to be used on the backside of plastic laminated panel substrates to enhance dimensional stability of the substrate. Backing sheet thickness must be 0.020 inches. Provide backing sheets for all laminated casework components where plastic laminate finish is applied to only one surface of the component substrate.

2.4 COUNTERTOPS

2.4.1 Backing Sheet

Heavy gauge, BK 20.

2.4.2 Solid Surface

Provide quartz agglomerate material that is a homogeneous filled solid polymer; not coated, laminated or of a composite construction, complying with ICPA SS-1 and ICPA SS-1 for quartz agglomerate. Provide material that meets or exceeds the minimum physical and performance properties specified. Superficial damage to a depth of 0.01 inch must be repairable by sanding or polishing. Material thickness is as indicated on the drawings; required minimum thickness is 1/4 inch. Submit a minimum 4 inch by 4 inch sample of each color and pattern for approval; include full range of color and pattern variation. Retain approved samples as a standard for this work.

- a. Horizontal Surfaces: 3 centimeters or 1 1/4 inches thick material
- b. Provide materials that meet the emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type). Provide certification or validation of indoor air quality for solid surface fabrication products.

Fabricator must have at least three (3) years' experience with this

material. All joints are to be inconspicuous. Construct shapes as indicated on drawings. Provide stainless steel brackets as required by manufacturer.

2.5 MOISTURE CONTENT OF WOOD PRODUCTS

Air dry or kiln dry lumber. Kiln dry treated lumber after treatment. Maximum moisture content of wood products at time of delivery to the jobsite, and when installed, must be as follows:

- a. Interior Finish Lumber, Trim, and Millwork: 1-1/4 Inches Nominal or Less in Thickness: 6 percent on 85 percent of the pieces and 8 percent on remainder.
- b. Exterior Treated and Untreated Finish Lumber and Trim: 4 inches Nominal or Less in Thickness: 19 percent.
- c. Provide moisture content of other materials in accordance with the applicable standards.

2.6 PRESERVATIVE TREATMENT OF WOOD PRODUCTS

2.6.1 Non-Pressure Treatment

Treat woodwork and millwork, such as exterior trim, door trim, and window trim, in accordance with WDMA I.S.4, with either 2 percent copper napthenate, 3 percent zinc napthenate, or 1.8 percent copper-8-quinolinolate. Provide a liberal brush coat of preservative treatment to field cuts and holes.

2.6.2 Pressure Treatment

Treat lumber and plywood used on the exterior of buildings or in contact with masonry or concrete with a waterborne preservative listed in AWPA U1 (P series is included therein by reference) as applicable, and inspected in accordance with AWPA U1. Identify treatment on each piece of material by the quality mark of an agency accredited by the Board of Review of the American Lumber Standards Committee. Provide treated plywood to a reflection level as follows:

Preservative treat exterior wood moulding and millwork that will be within 18 inches of soil or in contact with water or concrete in accordance with WMMPA WM 6. Provide a field treatment in accordance with AWPA M4 of exposed areas of treated wood that have been cut or drilled. Items of all-heart material of cedar, cypress, or redwood do not require preservative treatment except when in direct contact with soil.

2.7 HARDWARE AND ACCESSORIES

Provide sizes, types, and spacings of hardware and accessories as recommended in writing by the wood product manufacturer, except as otherwise specified.

2.7.1 Wood Screws

ASME B18.6.1.

2.7.2 Bolts, Nuts, Lag Screws, and Studs

ASME B18.2.1 and ASME B18.2.2.

2.7.3 Nails

Use nails of a size and type best suited for each application and in accordance with ASTM F547. Use hot-dipped galvanized or aluminum nails for exterior applications. For siding, provide nails of sufficient length to extend 1-1/2 inches into supports, including wood sheathing over framing. Where nailing is impractical, provide screws of a size and type best suited for each application.

2.7.4 Counter Hardware

Undercounter bracket shall be equal to TMI A7453.

2.7.5 Cabinet Hardware

Furnished under Hardware Section (except as noted). Apply per manufacturer's instructions; fit accurately and securely. Refer to additional notes in Section Hardware. Employ power routers and jigs. Do not hammer screws into place. Adjust to operate smoothly and properly. Identify all keys for presentation to Owner. Where necessary, remove and replace hardware and doors to facilitate painting.

2.8 FABRICATION

2.8.1 Quality Standards (QS)

2.8.2 Grades

The terms "Premium," "Custom," and "Economy" refer to the quality grades defined in NAAWS 3.1. Provide items not otherwise specified in a specific grade as "Custom" grade.

2.8.3 Adhesives

Select adhesives for durability and permanent bonding. Address factors such as materials that must be bonded, expansion and contraction, bond strength, fire rating, moisture resistance, and manufacturer's recommendations.

Provide non-aerosol adhesive products used on the interior of the building (defined as inside of the weatherproofing system) meeting either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of SCAQMD Rule 1168. Provide aerosol adhesives used on the interior of the building meeting either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of GS-36. Provide certification or validation of indoor air quality for non-aerosol adhesives applied on the interior of the building (inside of the weatherproofing system). Provide certification or validation of indoor air quality for aerosol adhesives used on the interior of the building.

2.8.4 Countertops

2.8.4.1 Quartz Counter Tops

Fabricate all solid surfacing material, counter top components from 3/4 inch thick material. Indicate details, dimensions, locations, and quantities on the drawings. Provide counter tops with 4 inch high loose backsplash and loose endsplashes as indicated. Attach 2 inch wide reinforcing strip of solid surfacing material under each horizontal counter top seam. Submit a minimum 1 foot wide by 6 inch deep, full size sample for each type of counter top shown on the project drawings; include the edge profile and backsplash as detailed on the drawings and at least one seam. Retain approved sample as standard for this work. Provide square edge profile. Provide stainless steel support brackets as required by manufacturer. Undercounter bracket shall be equal to TMI A7453

2.8.5 Cabinets

Unless specified otherwise, provide wall and base cabinets of plastic laminate finish. Fabricate cabinets with solid ends and frame fronts, or with frames all around. Provide frames of solid hardwood not less than 3/4 by 1-1/2 inches. Provide ends, bottoms, backs, partitions, and doors as hardwood plywood. Mortise and tenon, dovetail, or dowel and glue joints to produce a rigid unit. Cover exposed edges of plywood with hardwood strips. Provide cabinet doors, frames, and solid exposed ends 3/4 inch thick minimum. Provide cabinet bottoms, partitions, and framed ends to be 1/2 inch minimum. Provide shelves to be 5/8 inch thick minimum. Provide cabinet backs 1/4 inch thick minimum.

2.8.5.1 Cabinet Hardware

ANSI/BHMA A156.9. Provide cabinet hardware for new cabinets including two self closing hinges for each door, two side mounted metal drawer slides for each drawer, and pulls for all doors and drawers as follows. Provide hardware exposed to view as bright chromium plated. Comply with the following requirements for all cabinet hardware:

- a. Provide frameless concealed European style, back mounted hinges with 165 degree opening and a self closing feature when at less than 90 degrees open.
- b. Provide drawer slides having a static rating capacity of 100 lbs.. Slides to have a self closing/stay closed action, zinc or epoxy coated steel finish, ball bearing rollers, and positive stop with lift out design.
- c. Provide drawer pulls matching in style and finish existing cabinet hardware indicated to remain. .
- d. Provide heavy duty magnetic drawer catches.

2.8.5.2 Finish

Provide a clear factory finish on wood surfaces after fabrication. Provide fabricator's standard natural finish equivalent to one coat of sealer, one coat of varnish on all surfaces and a second coat of varnish on surfaces exposed to view. Provide spar varnish in exterior or wet area applications. Sand lightly and wipe clean between coats.

2.8.6 Casework with High Pressure Laminate Finish

2.8.6.1 AWI Quality Grade

Custom grade.

2.8.6.2 Construction

Provide flush overlay design details.

2.8.6.3 Exposed Surfaces

High pressure plastic laminate, color and pattern as selected by Contracting Officer's Representative from manufacturer's full range.

2.8.6.4 Semi-Exposed Surfaces

As specified in the [NAAWS 3.1](#) for the grade selected.

PART 3 EXECUTION

Do not install building construction materials that show visual evidence of biological growth.

3.1 FINISH WORK

Apply primer to finish work before installing. Where practicable, shop assemble and finish millwork items. Construct joints tight and in a manner to conceal shrinkage but to avoid cupping, twisting and warping after installation. Miter trim and mouldings at exterior angles; cope at interior angles and at returns. Provide millwork and trim in maximum practical lengths. Fasten finish work with finish nails. Provide blind nailing where practicable. Set face nails for putty stopping.

3.1.1 Exterior Finish Work

Machine sand exposed flat members and square edges. Machine finish semi-exposed surfaces. Construct joints to exclude water. In addition to nailing, glue joints with waterproof glue as necessary for weather resistant construction. Evenly distribute end joints in built-up members. Provide shoulder joints in flat work. Reinforce backs of wide-faced miters with metal rings and waterproof glue. Unless otherwise indicated, provide fascia and other flat members [3/4 inch](#) thick minimum. Provide door and window trim in single lengths. Provide braced, blocked, and rigidly anchored cornices for support and protection of vertical joints. Provide soffits in largest practical size. Align joints of plywood over centerlines of supports. Fasten soffits with aluminum or stainless steel nails. Back prime all concealed surfaces of exterior trim.

3.1.2 Interior Finish Work

After installation, sand exposed surfaces smooth. Provide window and door trim in single lengths.

3.1.3 Door Frames

Set plumb and square. Provide solid blocking at not more than [16 inches](#) on center for each jamb. Position blocking to occur behind hinges and lock strikes. Double wedge frames and fasten with finish nails. Set

nails for putty stopping.

3.1.4 Thresholds

Unless otherwise indicated, provide thresholds $\frac{5}{8}$ inch thick by $2\text{--}\frac{5}{8}$ inches wide with beveled sides and cut to fit at jambs. Fasten thresholds with casing nails. Set nails for putty stopping.

3.1.5 Window Stools and Aprons

Provide stools with rabbets over window sills. Provide aprons with returns cut accurately to profile of member.

3.2 SHELVING

Support 1 inch nominal thick wood shelf material or $\frac{3}{4}$ or $\frac{23}{32}$ inch thick plywood shelf material with end and intermediate supports arranged to prevent buckling and sagging. Provide cleats except where hook strips are specified or indicated.

3.2.1 Storage Rooms

Unless otherwise indicated, provide storage rooms with shelves $11\text{--}\frac{1}{4}$ inches wide, bottom shelf 18 inches above the floor, top shelf 18 inches below the ceiling, and intermediate shelves approximately 18 inches apart.

3.3 MISCELLANEOUS

3.3.1 Countertops

Conceal fastenings where practicable. Fit counters tight to adjoining surfaces and scribe where necessary. Provide scribed joints neat and flush. Provide counter sections in longest lengths practicable with a minimum number of joints. Where joints are necessary, provide tight joints drawn up with concealed type heavy pull-up bolts. Glue joints with water resistant glue and make rigid with screws, bolts, or other approved fastenings.

3.3.2 Cabinets

Provide cabinets level, plumb, true, and tight to adjacent walls. Secure cabinets to walls with concealed toggle bolts. Secure top to cabinet with concealed screws. Make cutouts for fixtures from templates supplied by fixture manufacturer. Locate cutouts for pipes so that edges of holes are covered by escutcheons after installation.

3.3.3 Catwalks in Attic Spaces

Lay boards with 1 inch spaces between. Stagger end joints, with each joint on a support.

3.4 FASCIA AND EXTERIOR TRIM

Construct, caulk, and machine sand exposed surfaces and edges to exclude water. In addition to nailing, glue joints as necessary for weather resistance. Evenly distribute end joints in built-up members. Shoulder joints in flat work. Reinforce backs of wide-faced miters with metal rings and glue. Provide fascia and other flat members in maximum practicable lengths. Braced, block, and rigidly anchor cornices for

support and protection of vertical joints.

3.5 MOULDING AND INTERIOR TRIM

Install mouldings and interior trim straight, plumb, level and with closely fitted joints. Provide exposed surfaces machine sanded at the shop. Cope returns and interior angles at moulded items and miter external corners. Shoulder intersections of flatwork to ease any inherent changes in plane. Provide window and door trim in single lengths. Blind nail to the extent practicable. Set and stop face nailing with a nonstaining putty to match the applied finish. Use screws for attachment to metal; set and stop screws in accordance with the same quality requirements for nails.

-- End of Section --

SECTION 07 14 00

POLYMER-MODIFIED CEMENT WATERPROOFING

02/12, CHG 2: 02/18

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM C109/C109M (2021) Standard Test Method For Compressive Strength Of Hydraulic Cement Mortars (Using 2-In. Or 50mm Cube Specimens)

ASTM C348 (2021) Standard Test Method For Flexural Strength Of Hydraulic-Cement Mortars

ASTM D1751 (2018) Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)

NSF INTERNATIONAL (NSF)

NSF/ANSI 61 (2022) Drinking Water System Components - Health Effects

1.2 SUBMITTALS

Government approval is required for submittals . Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Protection Board

Polymer-Modified Cement Waterproofing

Submit material description and physical properties, application details, and recommendations regarding shelf life, application procedures, and precautions on flammability and toxicity.

SD-06 Test Reports

Moisture Meter

SD-11 Closeout Submittals

Warranty

Include copies of Safety Data Sheets for maintenance/repair

materials.

1.3 PREWATERPROOFING CONFERENCE

Prior to starting application of waterproofing system, arrange and attend a prewaterproofing conference to ensure a clear understanding of drawings and specifications. Give the Contracting Officer 7 days advance written notice of the time and place of meeting.

1.4 DELIVERY, STORAGE, AND HANDLING

Deliver waterproofing materials in manufacturer's original, unopened containers, with labels intact and legible. Containers of materials covered by a referenced specification number shall bear the specification number, type, and class of the contents. Deliver materials in sufficient quantity to continue work without interruption. Store and protect materials in accordance with manufacturer's instructions, and use within their indicated shelf life. When hazardous materials are involved, adhere to special precautions of the manufacturer, unless precautions conflict with local, state, and federal regulations. Promptly remove from the site materials or incomplete work adversely affected by exposure to moisture or freezing. Store materials on pallets and cover from top to bottom with canvas tarpaulins.

1.5 ENVIRONMENTAL CONDITIONS

Apply materials when ambient temperature is 40 degrees F or above for a period of 24 hours prior to the application and when there is no ice, frost, surface moisture, or visible dampness on the substrate surface. Apply materials when air temperature is expected to remain above 40 degrees F during the cure period recommended by the manufacturer. Moisture test for substrate is specified under paragraph entitled "Moisture Test." Work may be performed within heated enclosures, provided the surface temperature of the substrate is maintained at a minimum of 40 degrees F for 24 hours prior to the application of the waterproofing, and remains above that temperature during the cure period recommended by the manufacturer.

1.6 WARRANTY

Provide waterproofing system material and workmanship warranties meeting specified requirements. Provide revisions or amendment to standard manufacturer warranty to comply with the specified requirements. Minimum manufacturer warranty shall have no dollar limit, cover full system water-tightness, and shall have a minimum duration of 20 years.

1.6.1 Waterproofing System Installer Warranty

The roof system installer must warrant for a minimum period of two years that the waterproofing system, as installed, is free from defects in installation workmanship, to include the installation integral to a complete watertight foundation system assembly. Write the warranty directly to the Government.

1.6.2 Continuance of Warranty

Approve repair or replacement work that becomes necessary within the warranty period and accomplished in a manner so as to restore the integrity of the foundation waterproofing system assembly and validity of

the membrane manufacturer warranty for the remainder of the manufacturer warranty period.

PART 2 PRODUCTS

2.1 POLYMER-MODIFIED CEMENT WATERPROOFING

2.1.1 Description

A portland-cement based coating for concrete and masonry that resists both positive and negative hydrostatic pressure and is breathable, allowing interior moisture to escape without damaging coating

2.1.2 Performance Requirements:

Provide patching material complying with the following requirements:

1. Compliances: NSF/ANSI 61 for potable water contact.
2. Service temperatures: Immersion, up to 140 degrees F (60 degrees C); cleaning water, up to 200 degrees F (93 degrees C); dry air, up to 220 degrees F (104 degrees C).
3. VOC: 0 lbs/gal (0 g/L) less water and exempt solvents.
4. Initial Set, minutes at 70 degrees F (21 degrees C), 50 percent relative humidity: 10 minutes per lab method.
5. Final Set, minutes at 70 degrees F (21 degrees C), 50 percent relative humidity: 90 minutes per lab method.
6. Density (cured): 129 pounds per foot (2,080 kg/m) per lab method.
7. Positive resistance to hydrostatic pressure, hrs, at 200 psi (1.4 MPa), 461 head feet, air cured at 70 degrees F (21 degrees C) 50 percent relative humidity: 752 (No leakage, no softening) per CRD C 48, modified.
8. Negative resistance to hydrostatic pressure, hours, at 200 psi (1.4 MPa), 461 head feet, air cured at 70 degrees F (21 degrees C) 50 percent relative humidity: 664 (Limited dampness) per CRD C 48, modified.
9. Water absorption, boiling water submersion at 24 hours: 3.6 percent per ASTM C67/C67M (Section 7.3).
10. Compressive strength, ASTM C109/C109M:
 - a. 7 days: 4,200 psi (29 MPa)
 - b. 28 days: 6,030 psi (42 MPa)
11. Flexural strength, ASTM C348:
 - a. 7 days: 360 psi (2.5 MPa)
 - b. 28 days: 1,027 psi (7 MPa)
12. Tensile strength, ASTM C190/C190M:
 - a. 7 days: 250 psi (2 MPa).
 - b. 28 days: 440 psi (3 MPa).
13. Modulus of elasticity, ASTM C469/C469M, 28 days: 2.72×10 to the

6th psi (1.87×10 to the 4th MPa).

14. Artificial weathering, hrs:
 - a. Xenon Arc: 5,000 = No failure per ASTM G26/G26M.
 - b. Carbon Arc: 500 = No failure per ASTM G23/G23M.
15. Adhesion strength, Test by tensile bond: 418 psi (2.9 MPa).
16. Artificial weathering, Atlas Type DMC weatherometer: No cracking, loss of adhesion, checking or other defect.
17. Freeze/thaw resistance, 200 cycles: No change per ASTM C666/C666M (Procedure B).
18. Salt spray resistance, 300 hours: No defect per ASTM B117.
19. Carbon Dioxide (CO₂), 1/16 inch (1.6 mm) per Lab Method Diffusion. Equivalent to 3/4 inch (19 mm) new concrete.
20. Permeance:
 - a. Perms: 12 (0.10698) per ASTM E96/E96M
 - b. Metric permeability 18×10 to the 3rd resistance (water-vapor transmission) per Swedish standard SS-02-15-82.
21. Wind-driven rain, hrs: 8 = excellent per Fed. Spec. TT-P-0035 (Para 4.4.7).
22. Coefficient of thermal expansion in/in/degree F (mm/mm/degree C), at 28 days: 6.99×10 to the minus 6th (5×10 to the minus 7th) per ASTM C531.
23. Impact strength (Gardener impact tester): No chipping per Fed. Spec. TT-P-0035 (Cement paints para. 3.4.8)
24. Hardness, (Barber Coleman Impressor) Requirement min = 30, max = 60 (para 4.4.9) Fed. Spec. TT-P-0035:
 - a. 7 days: 35.
 - b. 14 days: 47.
 - c. 21 days: 52.
25. Abrasion resistance 3,000 L sand: Passed per Fed. Spec. TT-P-141B.
26. Fungus resistance at 21 days: No growth; meets all requirements of Fed. Spec. TT-P-29B.
27. Surface burning characteristics per ASTM E84:
 - a. Flame Spread: 0.
 - b. Smoke developed: 5.
28. Fire Propagation Flame spread: Index = 1.5, Class 1 per BS476: Part 6:1981, BS476: Part 7:1971.

2.2 JOINT FILLER

As specified in [ASTM D1751](#) .

2.3 PROTECTION BOARD

Premolded bitumen composition board, [1/8 inch](#) minimum thickness or other

composition board compatible with the fluid-applied membrane.

PART 3 EXECUTION

3.1 PREPARATION

Coordinate work with that of other trades to ensure that components to be incorporated into the waterproofing system are available when needed. Inspect and approve surfaces immediately before application of waterproofing materials. Remove laitance, loose aggregate, sharp projections, grease, oil, dirt, curing compounds, and other contaminants which could adversely affect the complete bonding of the fluid-applied membrane to the concrete surface.

If efflorescence is present, mechanically remove it before proceeding.

Patch holes and cracks before installation.

Roughen or brush blast extremely smooth surfaces to ensure good mechanical adhesion.

3.2 SPECIAL PRECAUTIONS

Protect waterproofing materials during transport and application. Do not dilute primers and other materials, unless specifically recommended by materials manufacturer. Keep containers closed except when removing contents. Do not mix remains of unlike materials. Thoroughly remove residual materials before using application equipment for mixing and transporting materials. Do not permit equipment on the project site that has residue of materials used on previous projects. Use cleaners only for cleaning, not for thinning primers or membrane materials. Ensure that workers and others who walk on cured membrane wear clean, soft-soled shoes to avoid damaging the waterproofing materials.

3.3 APPLICATION - GENERAL

- A. Apply coating with manufacturer recommended brush or broom or equivalent stiff fiber brush or with textured spray equipment. Spray, back-brush, or broom applications of first coat to fill voids and achieve uniformity.
- B. Completely dampen substrate with water before starting application. Do not saturate substrate. Keep substrate cool and damp throughout application.
- C. Work first coat thoroughly into substrate to completely fill and cover voids, holes and nonmoving cracks.
- D. Allow to cure 24 hours, then apply second coat and finish with vertical stroke.
- E. On concrete block or masonry walls, allow 5 to 7 days before applying second coat to eliminate joint read through.

3.4 BASEMENT WALLS INTERIOR APPLICATION

- A. Application: Apply two heavy coats of polymer-modified cement waterproofing to basement walls; Spray and back-brush coat of standard coating at 4 pounds per square yard (2.2 kg/sm).

- B. Cut out intersection of floor/wall and install waterstop cove seal at wall and floor junction prior to application of base coat.

3.5 FIELD QUALITY CONTROL

3.5.1 Moisture Test

Prior to application of waterproofing, measure moisture content of substrate with a [moisture meter](#) in the presence of the Contracting Officer. Do not begin application until meter reading indicates "dry" range.

3.5.2 Film Thickness

Measure wet film thickness every [100 square feet](#) during application by placing flat metal plates on the substrate or using a mil-thickness gage especially manufactured for the purpose.

3.6 CLEANING

- A. Clean waterproofing material from tools and equipment with water. Remove cured materials mechanically.
- B. Clean up and properly dispose of debris remaining on Project site related to application.
- C. Remove temporary coverings and protection from adjacent Work areas.

3.7 PROTECTION

- A. Protect system from damage during construction.

-- End of Section --

SECTION 07 21 00

MINERAL FIBER BUILDING INSULATION
11/11, CHG 4: 08/18

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING
ENGINEERS (ASHRAE)

ASHRAE 90.1 - IP (2019; Errata 1 2019; Errata 2-5 2020; Addenda BY-CP 2020; Addenda AF-DB 2020; Addenda A-G 2020; Addenda F-Y 2021; Errata 6-8 2021; Interpretation 1-4 2020; Interpretation 5-8 2021 Addenda AS-AQ 2022) Energy Standard for Buildings Except Low-Rise Residential Buildings

ASTM INTERNATIONAL (ASTM)

ASTM C303 (2021) Standard Test Method For Dimensions And Density Of Preformed Block And Board-Type Thermal Insulation

ASTM C665 (2017) Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing

ASTM C930 (2019) Standard Classification of Potential Health and Safety Concerns Associated with Thermal Insulation Materials and Accessories

ASTM D3833/D3833M (1996; R 2011) Water Vapor Transmission of Pressure-Sensitive Tapes

ASTM D5359 (2015) Standard Specification for Glass Cullet Recovered from Waste for Use in Manufacture of Glass Fiber

ASTM E84 (2020) Standard Test Method for Surface Burning Characteristics of Building Materials

ASTM E136 (2022) Standard Test Method for Assessing Combustibility of Materials Using a Vertical Tube Furnace at 750 Degrees C

CALIFORNIA DEPARTMENT OF PUBLIC HEALTH (CDPH)

CDPH SECTION 01350 (2010; Version 1.1) Standard Method for

the Testing and Evaluation of Volatile
Organic Chemical Emissions from Indoor
Sources using Environmental Chambers

GREEN SEAL (GS)

GS-36 (2013) Adhesives for Commercial Use

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 54 (2021) National Fuel Gas Code

NFPA 70 (2023) National Electrical Code

NFPA 211 (2019) Standard for Chimneys, Fireplaces,
Vents, and Solid Fuel-Burning Appliances

SCIENTIFIC CERTIFICATION SYSTEMS (SCS)

SCS SCS Global Services (SCS) Indoor Advantage

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT (SCAQMD)

SCAQMD Rule 1168 (2017) Adhesive and Sealant Applications

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.134 Respiratory Protection

UNDERWRITERS LABORATORIES (UL)

UL 2818 (2013) GREENGUARD Certification Program
For Chemical Emissions For Building
Materials, Finishes And Furnishings

1.2 SUBMITTALS

Government approval is required for submittals . Submit the following in
accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Blanket Insulation

Recycled Content for Insulation Materials

Pressure Sensitive Tape

Accessories

Insulation Fasteners

Semi-Rigid Board Insulation

SD-07 Certificates

Indoor Air Quality for Adhesives

SD-08 Manufacturer's Instructions

Insulation

1.3 CERTIFICATIONS

Submit required indoor air quality certifications and validations in one submittal package.

1.3.1 Insulation Products

Provide product certified to meet indoor air quality requirements by [UL 2818](#) (Greenguard) Gold, [SCS](#) Global Services Indoor Advantage Gold or provide certification by other third-party programs. Provide current product certification from certification body.

1.3.2 Adhesives and Sealants

Provide products certified to meet indoor air quality requirements by [UL 2818](#) (Greenguard) Gold, [SCS](#) Global Services Indoor Advantage Gold or provide certification or validation by other third-party programs that products meet the requirements of this Section. Provide current product certification documentation from certification body. When product does not have certification, provide validation that product meets the indoor air quality product requirements cited herein.

1.4 DELIVERY, STORAGE, AND HANDLING

1.4.1 Delivery

Deliver materials to site in original sealed wrapping bearing manufacturer's name and brand designation, specification number, type, grade, R-value, and class. Store and handle to protect from damage. Do not allow insulation materials to become wet, soiled, crushed, or covered with ice or snow. Comply with manufacturer's recommendations for handling, storing, and protecting of materials before and during installation.

1.4.2 Storage

Inspect materials delivered to the site for damage; unload and store out of weather in manufacturer's original packaging. Store only in dry locations, not subject to open flames or sparks, and easily accessible for inspection and handling.

1.5 SAFETY PRECAUTIONS

1.5.1 Respirators

Provide installers with dust/mist respirators, training in their use, and protective clothing, all approved by National Institute for Occupational Safety and Health (NIOSH)/Mine Safety and Health Administration (MSHA) in accordance with [29 CFR 1910.134](#).

1.5.2 Other Safety Concerns

Consider other safety concerns and measures as outlined in [ASTM C930](#).

PART 2 PRODUCTS

2.1 BLANKET INSULATION

ASTM C665, Type I, blankets without membrane coverings, fiberglass or rock wool mineral fiber products; except a flame spread rating of 25 or less and a smoke developed rating of 150 or less when tested in accordance with ASTM E84.

2.1.1 Thermal Resistance Value (R-VALUE)

The R-Value not less than 11. .

2.1.2 Recycled Materials

Provide insulation materials containing the following minimum percentage of recycled material content by weight:

Fiberglass: 20 percent glass cullet complying with ASTM D5359

Provide data identifying percentage of recycled content for insulation materials.

2.1.3 Prohibited Materials

Do not provide asbestos-containing materials.

2.2 SEMI-RIGID BOARD INSULATION

Provide thermal insulating materials as recommended by manufacturer for each type of application indicated. Provide insulation with the following physical properties and in accordance with the following standards:

- a. Mineral Fiber Semi-rigid Board: ASTM C612, unfaced and foil faced as indicated

(1) Type IA Aluminum Foil on outer surfaces. Class 2 - Glass fiber reinforced core.

2.2.1 Thermal Resistance

Unless otherwise indicated, R value no less than 6.5.

2.2.2 Fire Protection Requirements

- a. Flame spread index of 15 or less when tested in accordance with ASTM E84.
- b. Smoke developed index of 50 or less when tested in accordance with ASTM E84.
- c. Provide insulated assemblies in accordance ICC IBC Chapter Fire and Smoke Protection Features.

2.2.3 Other Material Properties

Provide thermal insulating materials with the following properties:

- a. Density: 3.0 pcf per ASTM C303

- b. Mineral fiber board: Compressive strength: Minimum load required to produce a reduction in thickness of 10 percent pounds per square foot (lbf/sf): 25 when tested according to ASTM C165.

2.3 BLOCKING

Wood, metal, unfaced mineral fiber blankets in accordance with ASTM C665, Type I, or other approved materials. Use only non-combustible materials meeting the requirements of ASTM E136 for blocking around chimneys and heat producing devices.

2.4 PRESSURE SENSITIVE TAPE

As recommended by the vapor retarder manufacturer and having a water vapor permeance rating of one perm or less when tested in accordance with ASTM D3833/D3833M.

2.5 ACCESSORIES

2.5.1 Adhesive

As recommended by the insulation manufacturer. Provide non-aerosol adhesive products used on the interior of the building (defined as inside of the weatherproofing system) that meet either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of SCAQMD Rule 1168. Provide aerosol adhesives used on the interior of the building that meet either emissions requirements of CDPH SECTION 01350 (use the office or classroom requirements, regardless of space type) or VOC content requirements of GS-36. Provide certification or validation of indoor air quality for adhesives.

2.6 INSULATION FASTENERS:

Impaling clip of unfinished steel with washer retainer and clips, to be adhered to surface to receive insulation, length to suit insulation thickness and substrate, capable of securely and rigidly fastening insulation in place

- A. Adhesively Attached, Spindle-Type Anchors: Plate attached to projecting spindle; capable of holding insulation thickness indicated securely in position indicated with self-locking washer in place; and complying with the following requirements:
 - 1. Plate: Perforated stainless steel sheet, 0.03 in. thick by 2 in. square.
 - 2. Spindle: Stainless steel, 0.105 in. diameter, length to suit depth of insulation indicated.
 - 3. Anchor Adhesives: Product with demonstrated capability to permanently bond insulation anchors securely to substrates indicated without damaging insulation, fasteners, and substrates.
 - 4. Insulation-Retaining Washers: Self-locking washers formed from 0.016 in. thick galvanized sheet.

PART 3 EXECUTION

3.1 EXISTING CONDITIONS

Before installing insulation, ensure that areas that will be in contact with the insulation are dry and free of projections which could cause voids, compressed insulation, or punctured vapor retarders. If moisture or other conditions are found that do not allow the workmanlike installation of the insulation, do not proceed but notify Contracting Officer of such conditions.

3.2 PREPARATION

3.2.1 Blocking at Attic Vents and Access Doors

Prior to installation of insulation, install permanent blocking to prevent insulation from slipping over, clogging, or restricting air flow through soffit vents at eaves. Install permanent blocking around attic trap doors.

Install permanent blocking to maintain accessibility to equipment or controls that require maintenance or adjustment.

3.2.2 Blocking Around Heat Producing Devices

Install non-combustible blocking around heat producing devices to provide the following clearances:

- a. Recessed lighting fixtures, including wiring compartments, ballasts, and other heat producing devices, unless these are certified by the manufacturer for installation surrounded by insulation: 3 inches from outside face of fixtures and devices or as required by NFPA 70 and, if insulation is to be placed above fixture or device, 24 inches above fixture.
- b. Vents and vent connectors used for venting the products of combustion, flues, and chimneys other than masonry chimneys: Minimum clearances as required by NFPA 211.
- d. Gas Fired Appliances: Clearances as required in NFPA 54.

Blocking around flues and chimneys is not required when insulation blanket, including any attached vapor retarder, passed ASTM E136, in addition to meeting all other requirements stipulated in Part 2. Blocking is also not required if the chimneys are certified by the manufacturer for use in contact with insulating materials.

3.3 INSTALLATION

3.3.1 Insulation

Install and handle insulation in accordance with manufacturer's instructions. Keep material dry and free of extraneous materials. Any materials that show visual evidence of biological growth due to presence of moisture must not be installed on the building project. Ensure personal protective clothing and respiratory equipment is used as required. Observe safe work practices.

3.3.1.1 Electrical wiring

Do not install insulation in a manner that would sandwich electrical

wiring between two layers of insulation.

3.3.1.2 Continuity of Insulation

Install blanket insulation to butt tightly against adjoining blankets and to studs, rafters, joists, sill plates, headers and any obstructions. Avoid creating thermal bridges.

3.3.1.3 Installation at Bridging and Cross Bracing

Insulate at bridging and cross bracing by splitting blanket vertically at center and packing one half into each opening. Butt insulation at bridging and cross bracing; fill in bridged area with loose or scrap insulation.

3.3.1.4 Cold Climate Requirement

Place insulation to the outside of pipes.

3.3.1.5 Exterior Metal Stud Furred Walls (Furred Space) And Metal Studs Walls Separate Heated Space From Unheated Space:

Install unfaced blanket insulation in all exterior furred wall surface, carefully filling every void. Extend up to juncture with structure. Take care to cut and fit without compressing insulation at bridging and other interrupting members. Fill space around door frames etc. with insulation before closing.

3.3.1.6 Under Side of Roof Deck Between Rafters (Attic Space):

Install unfaced semi-rigid insulation board between rafters on underside of roof deck. Cut in carefully to fit between rafters and around any deck penetrations. Insulation shall comply with ASHRAE 90.1 - IP for prescribed R-values. Install with impaling clip fasteners. Bend or clip off excess spindle length. Space anchors to adequately secure insulation, but in no case less than 16 inches oc each way.

3.3.1.7 Sound Insulation at New Interior Partitions

Install unfaced insulation tightly within partition stud spaces, around cut openings, behind and around electrical and mechanical items within partitions, and tight to items passing through partitions.

3.3.1.8 Walls of Mechanical Room (Rooms Mech 1 and Mech 2)

Install foil faced semi-rigid board floor-to-ceiling on all interior walls of designated spaces. Cut in carefully around conduit, panels and other surface mounted equipment. Install with impaling clip fasteners. Secure spindle anchors with field applied adhesive. On surfaces within 7 feet of the floor, bend or clip off excess spindle length. Space anchors to adequately secure insulation, but in no case less than 16 inches oc each way. Supplement spindle clips with adhesive along edges near doorways and other sensitive areas.

3.3.1.9 Sizing of Blankets

Provide only full width blankets when insulating between trusses, joists, or studs. Size width of blankets for a snug fit where trusses, joists or studs are irregularly spaced.

3.3.1.10 Access Panels and Doors

Affix blanket insulation to access panels greater than one square foot and access doors in insulated ceilings. Use insulation with same R-Value as that for ceiling.

-- End of Section --

SECTION 07 27 26

FLUID-APPLIED MEMBRANE AIR BARRIERS
05/17, CHG 2: 08/20

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D1970/D1970M	(2019) Standard Specification for Self-Adhering Polymer Modified Bituminous Sheet Materials Used as Steep Roofing Underlayment for Ice Dam Protection
ASTM D4263	(1983; R 2018) Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method
ASTM D4541	(2017) Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers
ASTM D5590	(2000; R 2010; E 2012) Standard Test Method for Determining the Resistance of Paint Films and Related Coatings to Fungal Defacement by Accelerated Four-Week Agar Plate Assay
ASTM E84	(2020) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM E96/E96M	(2022a) Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials
ASTM E331	(2000; R 2016) Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference
ASTM E2178	(2021a) Standard Test Method for Air Permeance of Building Materials
ASTM E2357	(2017) Standard Test Method for Determining Air Leakage of Air Barrier Assemblies

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 285	(2012) Standard Fire Test Method for Evaluation of Fire Propagation

Characteristics of Exterior
Non-Load-Bearing Wall Assemblies
Containing Combustible Components

1.2 RELATED REQUIREMENTS

Coordinate the requirements of Section 09 24 23 - Cement Stucco and other building enclosure sections to provide a complete building air barrier system at building addition. Submit all materials, components and assemblies of the air barrier system together as one complete submittal package.

1.3 SUBMITTALS

Government approval is required for submittals. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Qualifications of Manufacturer

Qualifications of Installer

SD-02 Shop Drawings

Fluid-Applied Membrane Air Barrier

SD-03 Product Data

Fluid-Applied Membrane Air Barrier

Transition Membrane

Primers, Adhesives, and Mastics

Safety Data Sheets

SD-04 Samples

Fluid-Applied Membrane Air Barrier Mockup

SD-06 Test Reports

Capillary Moisture Test

Field Peel Adhesion Test

Site Inspections Reports

SD-07 Certificates

Fluid-Applied Membrane Air Barrier

Transition Membrane

SD-08 Manufacturer's Instructions

Fluid-Applied Membrane Air Barrier

Transition Membrane

Primers, Adhesives, and Mastics

1.4 PERFORMANCE REQUIREMENTS

For fluid-applied membrane air barriers provide the following:

1.4.1 General

Air barrier shall be capable of performing as a continuous vapor-permeable air barrier and as a liquid-water drainage plane flashed to discharge to the exterior incidental condensation or water penetration. Air barrier assemblies shall be capable of accommodating substrate movement and of sealing substrate expansion and control joints, construction material changes, and transitions at perimeter conditions without deterioration and air leakage exceeding specified limits.

The building envelope shall be designed and constructed with a continuous air barrier to control air leakage into, or out of the conditioned space. An air barrier shall also be provided for interior partitions between conditioned space and space designed to maintain temperature or humidity levels which differ from those in the conditioned space by more than 50% of the difference between the conditioned space and design ambient conditions. The air barrier shall have the following characteristics:

1. It must be continuous, with all joints made airtight.
2. It shall have an air permeability not to exceed 0.004 cfm/sq. ft. under a pressure differential of 0.3 in. water (1.57 psf) (equal to 0.02 L/s. x sq. m. @ 75 Pa), when tested in accordance with ASTM E2178.
3. It shall have an air permeability not to exceed 0.04 cfm/sq. ft. under a pressure differential of 0.3 in. water (1.57 psf) (equal to 0.2 L/s. x sq. m. @ 75 Pa), when tested in accordance with ASTM E2357.
4. It shall be capable of withstanding positive and negative combined design wind, fan and stack pressures on the envelope without damage or displacement and shall transfer the load to the structure. It shall not displace adjacent materials under full load.
5. It shall be durable or maintainable.
6. The air barrier shall be joined in an airtight and flexible manner to the air barrier material of adjacent systems, allowing for the relative movement of systems due to thermal and moisture variations and creep. Connection shall be made between:
 - a. Foundation and walls
 - b. Walls and windows or doors
 - c. Different wall systems
 - d. Wall and roof
 - e. Wall and roof over unconditioned space
 - f. Walls, floor and roof across construction, control and expansion

joints

- g. Walls, floors and roof to utility, pipe and duct penetrations

- 7. All penetrations of the air barrier and paths of air infiltration/exfiltration shall be made airtight.

1.4.2 Shop Drawings

Show locations and extent of air barrier. Include details for substrate joints and cracks, counterflashing strip, penetrations, inside and outside corners, terminations, and tie-ins with adjoining construction.

- 1. Include details of interfaces with other materials that form part of air barrier
- 2. Include details of mockups

1.4.3 Product Data

Submit manufacturer's technical data indicating compliance with performance and environmental requirements, manufacturer's printed instructions for evaluating, preparing, and treating substrates, temperature and other limitations of installation conditions, safety requirements for installation, and [Safety Data Sheets](#). Indicate flame and smoke spread ratings for all products.

1.4.4 Mockup

Provide a mockup of the fluid-applied membrane air barrier. Apply product in an area designated by the Contracting Officer. Apply an area of not less than [54 square feet](#). Include all components specified as representative of the complete system. Notify the Contracting Officer a minimum of 48 hours prior to the test application. Select a test area representative of conditions to be covered including window or door openings, wall to ceiling transitions, flashings, and penetrations, as applicable.

1.4.5 Test Reports

Submit test reports indicating that capillary moisture tests and [field peel adhesion tests](#) on all substrate materials have been performed and the changes made, if required, in order to achieve successful and lasting adhesion. [Based on evaluation of comprehensive tests performed by a qualified testing agency, for air barriers, submit certified test report showing compliance with requirements specified for ASTM E2178.](#)

1.5 DELIVERY, STORAGE, AND HANDLING

1.5.1 Delivery

Deliver and store materials in sufficient quantity to allow for uninterrupted flow of work. Inspect materials delivered to the site for damage and store out of weather. Deliver materials to the jobsite in their original unopened packages, clearly marked with the manufacturer's name, brand designation, description of contents, and shelf life of containerized materials. Store and handle to protect from damage. [Remove damaged material from the site and dispose of in accordance with applicable regulations.](#)

1.5.2 Storage

Inspect materials delivered to the site for damage; unload and store out of weather in manufacturer's original packaging. Store only in dry locations, not subject to open flames or sparks, and easily accessible for inspection and handling. Do not double-stack pallets of fluid applied membrane components on the job site. Provide cover on top and all sides, allowing for adequate ventilation. Protect fluid-applied membrane components from freezing and extreme heat. Protect stored materials from direct sunlight.

1.6 CAPILLARY MOISTURE TEST

Perform a capillary moisture test by plastic sheet method in accordance with ASTM D4263 on the construction mockup and substrate materials. Perform test after curing period as recommended by the air barrier manufacturer. Record mode of failure and area which failed in accordance with ASTM D4263. Once the air barrier material manufacturer has established a minimum adhesion or moisture level for the product on the particular substrate, indicate on the inspection report whether this requirement has been met. Where the manufacturer has not declared a minimum adhesion or moisture value for their product and substrate combination, the inspector must record actual values.

1.7 FIELD PEEL ADHESION TEST

Perform a field peel adhesion test on a construction mockup. Test the applied product for adhesion in accordance with manufacturer's recommendations. Perform test after curing period recommended by the manufacturer. Record mode of failure and area which failed in accordance with ASTM D4541. When the manufacturer has established a minimum adhesion level for the product on the particular substrate, the inspection report must indicate whether this requirement has been met. Where the manufacturer has not declared a minimum adhesion value for their product/substrate combination, the inspector must record actual values.

1.8 QUALITY ASSURANCE

1.8.1 Qualifications of Manufacturer

Submit documentation verifying that Air barrier systems are manufactured and marketed by a firm with a minimum of 20 years' experience in the production and sales of waterproofing and air barriers. Manufacturers proposed for use, shall submit evidence of ability to meet all requirements specified, and include a list of projects of similar design and complexity completed within the past five years..

1.8.2 Qualifications of Installer

Submit documentation verifying that installer is a firm experienced in applying air barrier materials similar in material, design, and extent to those indicated for this Project, whose work has resulted in applications with a record of successful in-service performance.

1.9 PRECONSTRUCTION MEETING

Conduct a preconstruction meeting a minimum of two weeks prior to commencing work specified in this Section. Agenda must include, at a

minimum, construction and testing of construction mock up, sequence of construction, coordination with substrate preparation, materials approved for use, compatibility of materials, coordination with installation of adjacent and covering materials, and details of construction. Attendance is required by representatives of related trades including covering materials, substrate materials, adjacent materials, and materials and components of the fluid-applied membrane air barrier.

1.10 ENVIRONMENTAL CONDITIONS

1.10.1 Temperature

Install fluid-applied membrane air barrier within the range of ambient and substrate temperatures as recommended in writing by the fluid-applied membrane air barrier manufacturer. Do not apply fluid-applied membrane air barrier to a damp or wet substrate. Do not apply during inclement weather or when ice, frost, surface moisture, or visible dampness is present on surfaces to be covered, or when precipitation is imminent.

1.10.2 Exposure to Weather

Protect fluid-applied membrane air barrier products from direct exposure to rain, snow, sunlight, mist, and other extreme weather conditions. Replace, at no additional cost to the government, barrier products that have been exposed to ultraviolet (sun)light longer than allowed by manufacturer's written requirements.

1.11 WARRANTY

- A. Submit manufacturer's warranty that air barrier and accessories are free of defects at time of delivery and are manufactured to meet manufacturer's published physical properties and material specifications.
- B. Warranty Period: Five years from date of completion of the air barrier membrane installation.

PART 2 PRODUCTS

2.1 FLUID-APPLIED MEMBRANE AIR BARRIER

Provide a fluid-applied, vapor permeable acrylic membrane that cures to form a resilient, monolithic, fully bonded elastomeric membrane when applied to construction surfaces.. This barrier must exhibit no visible water leakage when tested in accordance with ASTM E331 and must perform as a liquid water drainage plane with thru-wall flashing to discharge incidental condensation and water penetration to the exterior of the building enclosure. Provide products suitable for use within temperature ranges specified by manufacturer for the location of the project.

2.1.1 Physical Properties

- a. Air Permeance (ASTM E2178): less than 0.004 CFM per sf at 1.57 psf.
- b. Air Leakage (ASTM E2357): Less than 0.04 CFM per sf at 1.57 psf at one inch.
- c. Water Vapor Permeance (Vapor Permeable Membrane) (ASTM E96/E96M, desiccant method b): 15.0 perms.

- d. Pull Adhesion: ASTM D4541: minimum 20 psi or substrate failure to glass faced wall board, minimum 100 psi to concrete/CMU
- e. Low temperature Flexibility and Crack Bridging (ASTM D1970/D1970M): Pass at minus 20 degrees F.
- f. Solids by Volume: minimum 50 percent.
- g. Flame propagation of wall assemblies (NFPA 285): Pass
- h. Surface Burning Characteristics (ASTM E84):
 - (1) Flame Spread Index Rating not higher than 75.
 - (2) Smoke Developed Index Rating not higher than 150.
- i. Resistance to Mold, Mildew and Fungal Growth (ASTM D5590): 0, No growth.

2.2 PRIMERS, ADHESIVES, AND MASTICS

Provide primers, adhesives, mastics, sealants and other accessories as recommended by manufacturer of fluid-applied membrane air barrier for a complete installation.

2.3 TRANSITION MEMBRANE

A 0.9 mm (36 mils) of self-adhesive rubberized asphalt integrally bonded to 0.1 mm (4 mil) of cross-laminated, high-density polyethylene film to provide a min. 1.0 mm (40 mil) thick membrane. Membrane shall be interleaved with disposable silicone-coated release paper until installed.

2.4 FLEXIBLE MEMBRANE WALL FLASHING:

A 0.8 mm (32 mils) of self-adhesive rubberized asphalt integrally bonded to 0.2 mm (8 mil) of cross-laminated, high-density polyethylene film to provide a min. 1.0 mm (40 mil) thick membrane. Membrane shall be interleaved with disposable silicone-coated release paper until installed,

2.5 JOINT SEALANTS

Provide a one-part, neutral curing, ultra-low modulus material designed for use with fluid-applied membranes, self-adhered membrane and tapes; 98 g/L maximum VOC content as specified in Section 07 92 00 JOINT SEALANTS.

Provide a liquid membrane for details, terminations and substrate Patching; a two-part, elastomeric, trowel grade material designed for use with fluid-applied membranes, self-adhered membranes and tapes; 10 g/L maximum VOC content.

PART 3 EXECUTION

3.1 EXAMINATION

Before installing fluid-applied membrane air barrier, examine substrates, areas, and conditions under which fluid-applied membrane air barrier assemblies will be applied, with installer present, for compliance with

requirements. Ensure the following conditions are met:

- a. Surfaces are sound, dry, even, and free of oil, grease, dirt, excess mortar or other contaminants detrimental to the adhesion of the membranes.
- b. Concrete and masonry surfaces are cured and dry, smooth without large voids, spalled areas or sharp protrusions. Do not proceed with installation until after minimum concrete curing period recommended by fluid-applied membrane air barrier manufacturer.
- c. Fill voids, gaps and spalled areas in substrate to provide an even plane. Strike masonry joints full flush.
- d. Verify substrate is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method in accordance with [ASTM D4263](#) and take suitable measures until substrate passes moisture test.
- e. Verify sealants used in substrates, and in joints between substrates, are compatible with fluid-applied membrane air barrier.

3.2 PREPARATION

Clean, prepare, and treat substrate in accordance with manufacturer's written instructions. Ensure clean, dust-free, and dry substrate for fluid-applied membrane air barrier application.

- a. Remove dust, dirt and other contaminants from joints and cracks before coating surfaces.
- b. Prepare, treat, and seal vertical and horizontal surfaces at terminations and penetrations through fluid-applied membrane air barrier.
- c. At changes in substrate plane, provide transition material (bead of sealant, mastic, extruded silicone sealant, membrane counterflashing or other material recommended by manufacturer) under transition membrane to eliminate all sharp 90 degree inside corners and to make a smooth transition from one plane to another.
- d. Provide mechanically fastened non-corrosive metal sheet to span gaps in substrate plane and to make a smooth transition from one plane to the other. Continuously support membrane with substrate.
- e. For exterior sheathing substrates, ensure that exterior sheathing is stabilized, with corners and edges fastened with appropriate screws. Treat all joints in accordance with the air barrier manufacturer's instructions prior to application of air barrier material. Allow sufficient time for joint treatments to fully cure before application of transition membranes and fluid-applied membrane air barrier.
- f. For concrete and masonry substrates, fill all voids and holes, particularly in mortar joints, with non-shrinking grout.
- g. Mask off and cover adjacent surfaces to protect from spillage and overspray.

3.3 INSTALLATION

3.3.1 Installation of Transition Membrane

Install transition membrane materials in accordance with the details on the drawings, and the following:

- a. Install transition membrane at all required locations prior to installation of the fluid-applied membrane air barrier.
- b. Verify transition membrane is fully adhered to substrate and that its surface is clean, dry and wrinkle free prior to installation of the fluid-applied membrane air barrier.
- c. Verify transition membrane completely covers all transition areas and will provide continuity of the finished fluid-applied membrane air barrier without gaps or cracks.

3.3.2 Installation of Flashing

Counterflash upper edge of thru-wall flashing and fluid-applied air barrier.

3.3.3 Installation of Fluid-Applied Membrane Air Barrier

Install materials in accordance with manufacturer's recommendations and the following:

- a. Apply fluid-applied membrane air barrier in single or dual coat application by spray or roller. Apply fluid-applied membrane air barrier within manufacturer's recommended temperature range for application.
- b. Apply fluid-applied membrane air barrier in manner and at rate and wet film thickness recommended by manufacturer to yield a finished dry film thickness of not less than 40 mils (min. 68 mil (1.7 mm) wet film thickness,) or as otherwise required by the manufacturer for the application substrate material and surface roughness.
- c. Apply fluid-applied membrane air barrier around all penetrations ensuring a complete and continuous air barrier. Lap fluid-applied membrane air barrier a minimum of 3 inch over transition membrane to seal leading edge.
- d. Seal membrane terminations, heads of mechanical fasteners, masonry tie fasteners, around penetrations, HVAC assemblies, plumbing and electrical assemblies, doors, windows, louvers, and other assemblies penetrating the fluid-applied membrane air barrier with a termination sealant recommended by the fluid-applied membrane air barrier manufacturer.
- e. Notify the Contracting Officer and Testing Agency upon completion of fluid-applied membrane air barrier installation. Air barrier materials and assemblies must remain exposed until tested and inspected by the Testing agency.
- f. Do not allow materials to come in contact with chemically incompatible materials.

3.4 FIELD QUALITY CONTROL

3.4.1 Site Inspections and Testing

Testing Agency: Owner may engage a qualified testing agency to perform tests and inspections and prepare test reports.

Inspections: Air barrier materials and installation are subject to inspection for compliance with requirements. Inspections may include the following:

1. Continuity of air barrier system has been achieved throughout the building envelope with no gaps or holes.
2. Continuous structural support of air barrier system has been provided.
3. Masonry and concrete surfaces are smooth, clean and free of cavities, protrusions, and mortar droppings.
4. Site conditions for application temperature and dryness of substrates have been maintained.
5. Maximum exposure time of materials to UV deterioration has not been exceeded.
6. Surfaces have been primed, if applicable.
7. Laps in strips and transition membrane have complied with minimum requirements and have been shingled in the correct direction (or mastic has been applied on exposed edges), with no fish-mouths.
8. Termination sealant has been applied on cut edges.
9. Strips and transition membrane have been firmly adhered to substrate.
10. Compatible materials have been used.
11. Transitions at changes in direction and structural support at gaps have been provided.
12. Connections between assemblies (membrane and sealants) have complied with requirements for cleanliness, preparation and priming of surfaces, structural support, integrity, and continuity of seal.
13. All penetrations have been sealed.

3.4.2 Tests:

Testing to be performed will be determined by Owner's testing agency from among the following tests:

1. Qualitative Testing: Air barrier assemblies will be tested for evidence of air leakage according to ASTM E1186.
2. Remove and replace deficient air barrier components and retest as specified above.

3.5 PROTECTION AND CLEANING

3.5.1 Protection

Protect fluid-applied membrane air barrier assemblies from damage during application and remainder of construction in accordance with manufacturer's written instructions. Protect air barrier from exposure to UV light and harmful weather exposure as required by manufacturer.

Coordinate installation, testing, and inspection procedures to ensure exposure period does not exceed that recommended by the product manufacturer. Remove and replace, at no additional cost to the government, main air barrier material exposed for more than 180 days.

3.5.2 Cleaning of Adjacent Surfaces

Clean excess product from adjacent construction using cleaning agents and procedures as recommended in writing by the manufacturer of each type of affected construction and as acceptable to same.

Remove masking materials after installation.

3.6 CLEANUP OF SPILLS

Conduct cleanup of uncured product spillage in accordance with manufacturer's written safe handling instructions.

-- End of Section --

SECTION 07 41 13

METAL ROOF TILES
04/06

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B18.6.1 (2016) Wood Screws (Inch Series)

ASTM INTERNATIONAL (ASTM)

ASTM D412 (2016) Standard Test Methods for
Vulcanized Rubber and Thermoplastic
Elastomers - Tension

ASTM E108 (2020a) Standard Test Methods for Fire
Tests of Roof Coverings

NATIONAL ROOFING CONTRACTORS ASSOCIATION (NRCA)

NRCA 0437 (2017) The NRCA Roofing Manual:
Steep-slope Roof Systems

1.2 SUBMITTALS

Government approval is required for submittals. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Metal Tile Roofing System

SD-03 Product Data

Metal Tile Roofing System

Underlayment Membrane

Flexible Hip and Ridge Flashing

Submit data including tile properties , styles, and
configurations.

Sealant

Metal Roof Tiles

SD-04 Samples

Metal Roof Tiles

Submit a sample size of 6 by 6 inches .

SD-06 Test Reports

Self-Adhering Membrane Underlayment

SD-07 Certificates

Qualifications of roofing personnel

SD-08 Manufacturer's Instructions

Installation

1.3 DELIVERY AND STORAGE

Deliver materials in the manufacturer's unopened bundles and containers bearing the manufacturer's brand name. Keep materials dry, completely covered, and protected from the weather. Store according to manufacturer's written instructions.

1.4 WARRANTIES

1.4.1 Contractor's Warranty

The Contractor shall warrant for 50 years that the tile roofing system, as installed, is free from defects in workmanship.

Warranty shall cover resistance to blow-off in wind speed up to 120 mph, and resist hail stone penetration, cracks or splits from hail stone up to 2.5 inches.

When repairs due to defective workmanship or covered damage are required during the Contractor's warranty period, the Contractor shall make such repairs within 72 hours of notification. When repairs are not performed within the specified time, emergency repairs performed by others will not void the warranty.

1.5 COORDINATION

Coordinate with the installation of flashing and gutters provided under Section 07 60 00 FLASHING AND SHEET METAL to ensure proper sequencing. Do not install roofing materials until vent stacks and other penetrations through roof deck have been installed.

1.6 EXTRA STOCK

Provide an extra two percent of each type and color of tile used in clean marked containers. In the extra stock provided, include hip, ridge, and other special shapes in the same proportion as used on the project.

1.7 QUALITY ASSURANCE

1.7.1 Qualifications of Roofing Personnel

Installer's Qualifications: Provide installer regularly engaged in installation of roof panels of similar type to that specified for a minimum of 5 years. Use persons trained for installation of roof panels.

Submit documentation showing qualifications of personnel proposed to perform the roofing work and a listing identifying prior installations completed by the Contractor.

1.7.2 Metal Tile Roofing System Drawings

Submit drawings showing clay tile roofing installation and details for appearance, flashing and fastening of tiles.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Sheet Metal Materials:

Aluminum-Zinc Alloy Coated Steel sheet: ASTM A792/A792M, Class AZ50 (AZ150) coating designation; minimum Grade 37 (Grade 255).

2.1.2 Metal Roof Tiles

- A. Interlocking metal panels, resembling dimensional old-world Italian barrel tiles.
- B. Material: Pre-corrugated, pressure-formed, aluminum-zinc alloy-coated steel, with multiple vertical barrel tiles in a panel.
- C. Thickness: 26 gauge, 0.0179 inch (0.455 mm).
- D. Finish: Ceramic-coated, colored-stone chip finish.
- E. Color: to be selected by the Contracting Officer.
- F. Dimensions:
 - 1. Overall Panel Size: 17 inches (432 mm) wide by 44-1/4 inches (1,124 mm) long.
 - 2. Installed Panel Exposure: 14-1/2 inches (368 mm) wide by 39-1/2 inches (1,003 mm) long.
 - 3. Side Panel Laps: 4-3/4 inches (121 mm).
 - 4. Panel Leading Edges Bent Down: 1 inch (25 mm); provides overlap for weather protection and nailing purposes.
- G. Installed Weight: 150 pounds per 100 square feet.
- H. Recycled Steel Content: Maximum 30 percent.
- I. Non-Combustible, ASTM E108, UL 790: Class A.
- J. Impact Resistance, UL 2218: Class 4.

2.1.3 Flashing

2.1.3.1 Valley:

Aluminum-zinc alloy-coated steel sheet

- a. Pressure formed into valley with stone-coated valley cap.
- b. Thickness: 26 gauge, 0.0179 inch (0.455 mm).
- c. Finish: Match upper-exposed stone-coated surface of valley cap to shingle material.

2.1.3.2 Side Flashing:

Aluminum-zinc alloy-coated steel sheet,

- a. Pressure formed to flash vertical roof surface transitions.
- b. Thickness: 26 gauge, 0.0179 inch (0.455 mm).
- c. Finish: Ceramic-coated, colored-stone chip finish to match roofing material.

2.1.3.3 Roof-to-Wall Flashing:

Aluminum-zinc alloy-coated steel sheet

- a. Pressure formed to flash vertical roof surface transitions.
- b. Thickness: 26 gauge, 0.0179 inch (0.455 mm).
- c. Finish: Match color to exterior finish.

2.1.3.4 Pipe Jack Flashing:

Galvanized or aluminum-zinc alloy-coated steel.

- a. Thickness: 26 gauge, 0.0179 inch (0.455 mm).
- b. Finish: Clean, prime, and paint to match roof material.

2.1.3.5 Underpan:

Aluminum-zinc alloy-coated steel sheet .

- a. Pressure formed to counter flash roof penetrations matching roof panel material profile.
- b. Thickness: 26 gauge, 0.0179 inch (0.455 mm).

2.1.3.6 Fascia Metal:

Aluminum-zinc alloy-coated steel sheet,

- a. Pressure formed angle installed at first course to cover under-tile panel voids.
- b. Finish: Ceramic-coated, colored-stone chip finish to match roofing material.

2.1.3.7 Hip and Ridge:

Hip and Ridge covers, fasciae, drips, rakes, and other trim required,

matching shingle material, color, and finish.

- a. Aluminum-zinc alloy-coated steel sheet.
- b. Pressure formed to match roofing material.
- c. Thickness: 26 gauge, 0.0179 inch (0.455 mm).
- d. Finish: Color and finish to be applied along hips, ridges, and rakes.

2.2 UNDERLAYMENT MEMBRANE

Provide underlayment membrane on surfaces that will be covered with tile. Membrane shall consist of high strength composite self-adhering membrane.

2.2.1 Flexible Hip and Ridge Flashing

SBS modified rubberized asphalt adhesive on a lineal, low density polyethylene membrane with a 60 mil total thickness.

2.2.2 Self-Adhering Membrane Underlayment

ASTM D412, high strength polyethylene-sheet-backed, rubberized asphalt membrane, 40 mil thickness.

2.2.3 Primer for Self-Adhering Membrane Underlayment

VOC compliant primer as recommended by membrane manufacturer for application on concrete substrates.

2.3 FASTENERS

2.3.1 Screws

Wood Screws; ASME B18.6.1 corrosion resistant; Minimum No. 10, 1.25 inches long, or of sufficient length to penetrate substrate 3/4 inch minimum with either a black or color finish matching the panels.

2.4 SEALANT

One-part elastomeric polyurethane sealant, ASTM C920. Color to match roof panels.

PART 3 EXECUTION

3.1 EXAMINATION

Examine structural roof deck for compliance with requirements of selected system. Verify that roof penetrations and openings are installed in their proper location.

3.2 PREPARATION

3.2.1 Cleaning

Clean substrate of any projects and substances detrimental to metal panel roofing. Cover knotholes or other minor voids in substrate with sheet metal flashing secured with roofing nails. Coordinate installation of metal panels with flashing and other adjoining work to ensure proper

sequencing. Do not install roofing until vent stacks and other penetrations through roofing have been installed, are securely fastened and flashing is in place. Inspect and verify exterior stucco and DEFS wall enclosures are completed

3.3 INSTALLATION

Comply with manufacturer's installation instructions and recommendations, but not less than recommended by **NRCA 0437**. Comply with local building code requirements for special fastening requirements such as wind locks and hurricane clips in high wind areas.

3.3.1 Self-Adhering Membrane Underlayment

Apply self-adhering membrane over wood deck in accordance with manufacturers recommendations.

3.3.2 Metal Roof Tile Installation

A. Install roof panels weathertight.

B. Valleys: Install in accordance with manufacturer's instructions with a minimum 6-inch (152-mm) overlap in direction of flow.

C. Flashing: Install as indicated on the Drawings and in accordance with manufacturer's instructions.

D. Roof Panels:

1. Install roof panels, accessories, flashing, and hip and ridge level and plumb.
2. Use fasteners as specified and in accordance with manufacturer's instructions.
3. Install each panel using a random stagger pattern in accordance with manufacturer's instructions.
4. Fasten each panel with minimum 4 screws minimum horizontally into back-shelf tabs of each panel.

E. Cut roof panels into each side of valleys in accordance with manufacturer's instructions straight and true to the line of the valley.

F. Hip and Ridge:

1. Install hip and ridge along hips, ridges, and rakes as indicated on the Drawings and in accordance with manufacturer's instructions.
2. Bend and fold exposed ends of hips and ridges and neatly cap with end cap or piece of similar material.

G. Do not install roof panels in a manner that detracts from appearance of roof.

1. Do not rack panels.
2. Do not line panels vertically up the roof.

3. Do not use even panel offsets.

4. Do not make a pattern with panels.

3.3.3 ADJUSTING

A. Repair minor damages to roof panels in accordance with manufacturer's instructions and as approved by Architect.

B. Remove and replace with new material, damaged components that cannot be successfully repaired, as determined by Architect.

3.3.4 CLEANING AND PROTECTION

A. Clean roof panels of debris, including metal shavings, promptly after installation.

B. Protect Work of this Section to ensure that, except for normal weathering, Work will be without damage or deterioration at time of Substantial Completion.

-- End of Section --

SECTION 07 54 19

THERMOPLASTIC POLYOLEFIN (TPO) ROOFING
02/13, CHG 3: 02/21

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI/SPRI ES-1 (2003) Wind Design Standard for Edge Systems Used with Low Slope Roofing Systems

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7-16 (2017; Errata 2018; Supp 1 2018) Minimum Design Loads and Associated Criteria for Buildings and Other Structures

AMERICAN SOCIETY OF SAFETY PROFESSIONALS (ASSP)

ASSP A10.24 (2022) Roofing - Safety Requirements for Low-Sloped Roofs

ASTM INTERNATIONAL (ASTM)

ASTM E108 (2020a) Standard Test Methods for Fire Tests of Roof Coverings

FM GLOBAL (FM)

FM 4470 (2022) Single-Ply, Polymer-Modified Bitumen Sheet, Built-up Roof (BUR), and Liquid Applied Roof Assemblies for Use in Class 1 and Noncombustible Roof Deck Construction

FM APP GUIDE (updated on-line) Approval Guide
<http://www.approvalguide.com/>

NATIONAL ROOFING CONTRACTORS ASSOCIATION (NRCA)

NRCA 3621 (2017) Quality Control and Quality-assurance Guidelines for the Application of Membrane Roof Systems

NRCA 3740 (2005) The NRCA Waterproofing Manual

SINGLE PLY ROOFING INDUSTRY (SPRI)

ANSI/SPRI RD-1 (2014) Performance Standard for Retrofit Drains

U.S. DEPARTMENT OF ENERGY (DOE)

Energy Star

(1992; R 2006) Energy Star Energy
Efficiency Labeling System (FEMP)

UNDERWRITERS LABORATORIES (UL)

UL 790

(2022) UL Standard for Safety Test Methods
for Fire Tests of Roof Coverings

1.2 SUMMARY

Adhered or Mechanically fastened Thermoplastic Polyolefin (TPO) roof
membrane system applied over insulation substrate.

1.3 ASSEMBLY REQUIREMENTS

Provide roofing membrane sheet widths consistent with membrane attachment
methods and wind uplift requirements, and as large as practical. In order
to minimize joints and 3-way overlaps, prefabricated sheets are not
accepted. Provide membrane which is free of defects and foreign
material. Coordinate flashing work to permit continuous roof-surfacing
operations. Install insulation and weatherproofed planned sections on the
same day.

1.3.1 Fire Resistance

Complete roof system assembly:

- a. Class A or B rated in accordance with ASTM E108, FM 4470, or UL 790;
and
- b. Be listed as Class I roof deck construction in FM APP GUIDE.

FM or UL approved components of the roof covering assembly must bear the
appropriate FM or UL label.

1.3.2 Wind Uplift Resistance

Provide a complete roof system assembly that is rated and installed in
compliance with 2021 International Building Code for wind uplift
resistance requirements. Submit data for review indicating attachment
pattern and pull test to substantiate compliance with 2021 IBC wind speed
zone and uplift resistance. The attachment and the design of is the
contractors responsibility. Do not install non-rated systems, except as
approved by the Contracting Officer. Submit Engineering calculations,
signed, sealed, and dated by a Registered Engineer validating the wind
resistance per ASCE 7-16, and ANSI/SPRI ES-1 of non-rated roof system.

1.3.3 Solar Reflectance Index (SRI)

SRI measures the roof's ability to reject solar heat, defined such that a
standard black (reflectance 0.05, emittance 0.90) is 0 and a standard
white (reflectance 0.80, emittance 0.90) is 100. Use roofing materials
having minimum appropriate SRI for more than 75 percent of roof surface
(low slope (less than 2:12) SRI greater than 78; high slope (greater than
2:12) SRI greater than 29).

1.4 SUBMITTALS

Government approval is required for submittals . Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Detail Drawings

Roof Plan

SD-03 Product Data

TPO Roofing Membrane

Energy Star Label for roof membrane

Bonding Adhesive

Flashing

Membrane Fasteners and Plates

Roof Insulation

Water Cutoffs

Information Card

SD-05 Design Data

Wind Uplift Resistance

SD-07 Certificates

Qualification of Manufacturer

Qualifications of Applicator

Qualification of Engineer of Record

Wind Uplift Resistance

Fire Resistance classification

Sample Warranty

SD-08 Manufacturer's Instructions

Application Method

Membrane Flashing

Auxiliary Fasteners

Cold Weather

SD-11 Closeout Submittals

Warranty

Information Card

Instructions to Government Personnel

1.5 QUALITY ASSURANCE

1.5.1 Qualification of Manufacturer

TPO sheet roofing system manufacturer must have a minimum of 10 years experience in manufacturing TPO roofing products.

The manufacturer's technical service representative must agree to attend the Pre-work Conference, and to inspect work at start-up, approximate 50% stage and upon completion of roofing work. These inspections shall be arranged with the Architect and Contractor for a mutually agreed time; they shall be performed in the Architect's presence and a copy of the report of each inspection will be promptly furnished the Architect. Each inspection shall include a minimum of 4 hours of observation of the installation procedures.

Immediately after award of the project, the roofing manufacturer shall submit a letter indicating approval of the applicator, his compliance with the experience requirements indicated below, and willingness to make the stipulated inspections. The letter shall also have attached a specimen copy of the manufacturer's guarantee which meets the criteria set out below.

1.5.2 Qualifications of Applicator

Roofing system applicator must be approved, authorized, or licensed in writing by the TPO sheet roofing system manufacturer and have a minimum of five years experience as an approved, authorized, or licensed applicator with that manufacturer and be approved at a level capable of providing the specified warranty. Supply the names, locations and client contact information of five projects, within the previous three years, of similar size and scope that the applicator has constructed using the manufacturer's roofing products submitted for this project.

The full-time on-site job superintendent must meet these same requirements.

1.5.3 Qualification of Engineer of Record

Engineer of Record must be currently licensed within the jurisdiction of the project.

1.5.4 Conformance and Compatibility

Provide an entire roofing and flashing system that is in accordance with specified and indicated requirements, including fire and wind resistance.

1.5.5 Preroofing Conference

After approval of submittals and before performing roofing and insulation system installation work, hold a preroofing conference to review the following:

- a. Drawings, including roof plan, specifications and submittals related

to the roof work. Field inspection and verification of all existing conditions, including all fire safety issues, existing structure, and existing materials, including concealed combustibles, which may require additional protection during installation.

- b. Roof system components installation;
- c. Procedure for the roof manufacturer's technical representative's onsite inspection and acceptance of the roofing substrate, and roofing substrate, the name of the manufacturer's technical representatives, the frequency of the onsite visits, distribution of copies of the inspection reports from the manufacturer's technical representative to roof manufacturer;
- d. Contractor's plan for coordination of the work of the various trades involved in providing the roofing system and other components secured to the roofing; and
- e. Quality control(NRCA 3621) plan for the roof system installation;
- f. Safety requirements.

Coordinate prerooting conference scheduling with the Contracting Officer. The conference must be attended by the Contractor, the Contracting Officer's designated personnel, personnel directly responsible for the installation of roofing and insulation, flashing and sheet metal work, mechanical and electrical work, other trades interfacing with the roof work, designated safety personnel trained to enforce and copy with ASSP A10.24, and a representative of the roofing materials manufacturer. Before beginning roofing work, provide a copy of meeting notes and action items to all attending parties. Note action items requiring resolution prior to start of roof work.

1.6 DETAIL DRAWINGS

Submit roof plan depicting wind loads and boundaries of enhanced perimeter and corner attachments of roof system components, , spacing of perimeter, corner, and infield fasteners, as applicable. Provide drawings that reflect the project roof plan of each roof level and conditions indicated. Submit bids with approved detail drawings and specifications approved and furnished by the TPO membrane manufacturer.

1.7 DELIVERY, STORAGE, AND HANDLING

1.7.1 Delivery

Deliver materials in the manufacturer's original, unopened containers and rolls with labels intact and legible. Mark and remove wet or damaged materials from the site. Where materials are covered by a referenced specification number, the container must bear the specification number, type, class, and shelf life expiration date where applicable. Deliver materials in sufficient quantity to allow work to proceed without interruption.

1.7.2 Storage

Protect materials against moisture absorption and contamination or other damage. Avoid crushing or crinkling of roll materials. Store roll materials on end on clean raised platforms or pallets one level high in

dry locations with adequate ventilation, such as an enclosed building or closed trailer. Do not store roll materials in buildings under construction until concrete, mortar, and plaster work is finished and dry. Maintain roll materials at temperatures above 50 degrees F for 24 hours immediately before application. Do not store materials outdoors unless approved by the Contracting Officer. Completely cover felts stored outdoors, on and off roof, with waterproof canvas protective covering. Do not use polyethylene sheet as a covering. Tie covering securely to pallets to make completely weatherproof. Provide sufficient ventilation to prevent condensation. Do not store more materials on roof than can be installed the same day and remove unused materials at end of each days work. Distribute materials temporarily stored on roof to stay within live load limits of the roof construction.

- a. Maintain a minimum distance of 35 foot for all stored flammable materials, including materials covered with shrink wraps, craft paper or tarps from all torch/welding applications.
- b. Immediately remove wet, contaminated or otherwise damaged or unsuitable materials from the site. Damaged materials may be marked by the Contracting Officer.

1.7.3 Handling

Prevent damage to edges and ends of roll materials. Do not install damaged materials in the work. Select and operate material handling equipment to prevent damage to materials or applied roofing.

1.8 ENVIRONMENTAL REQUIREMENTS

Do not install roofing system when air temperature is below 40 degrees F, during any form of precipitation, including fog, or when there is ice, frost, moisture, or any other visible dampness on the roof deck. Follow manufacturer's printed instructions for Cold Weather Installation.

1.9 SEQUENCING

Coordinate the work with other trades to ensure that components which are to be secured to or stripped into the roofing system are available and that permanent flashing and counterflashing in accordance with NRCA 3740, are installed as the work progresses. Ensure temporary protection measures are in place to preclude moisture intrusion or damage to installed materials. Apply roofing immediately following application of insulation as a continuous operation. Coordinate roofing operations with insulation work so that all roof insulation applied each day is covered with roof membrane installation the same day.

1.10 WARRANTY

Provide roof system material and workmanship warranties. Provide revision or amendment to standard membrane manufacturer warranty as required to comply with the specified requirements. Provide a manufacturer's warranty that has no dollar limit, covers full system water-tightness, and has a minimum duration of 30 years. Submit sample certificate.

1.10.1 Roof Membrane Manufacturer Warranty

Furnish the roof membrane manufacturer's 30-year, no dollar limit roof system materials and installation workmanship warranty, including

flashing, insulation, and accessories necessary for a watertight roof system construction. Provide warranty directly to the Government commencing at the time of Government's acceptance of the building. The warranty must state that:

- a. If within the warranty period the roof system, as installed for its intended use in the normal climatic and environmental conditions of the facility, becomes non-watertight, shows evidence of moisture intrusion within the assembly, splits, tears, cracks, delaminates, separates at the seams, or shows evidence of excessive weathering due to defective materials or installation workmanship, the repair or replacement of the defective and damaged materials of the roof system assembly and correction of defective workmanship are the responsibility of the roof membrane manufacturer. All costs associated with the repair or replacement work are the responsibility of the roof membrane manufacturer.
- b. When the manufacturer or his approved applicator fail to perform the repairs within 72 hours of notification, emergency temporary repairs performed by others does not void the warranty.
- c. Standard manufacturer's roofing guarantees which contain language regarding the governing of the guarantee by any state other than the State of Alabama, must be amended to exclude such language, and substituting the requirement that the Laws of the State of Alabama shall govern all such guarantees.

1.10.2 Roofing System Installer Warranty

The roof system installer must warrant for a minimum period of two years that the roof system, as installed, is free from defects in installation workmanship, to include the roof membrane, flashing, insulation, accessories, attachments, and sheet metal installation integral to a complete watertight roof system assembly. Write the warranty directly to the Government. The roof system installer is responsible for correction of defective workmanship and replacement of damaged or affected materials. The roof system installer is responsible for all costs associated with the repair or replacement work.

1.10.3 Continuance of Warranty

Repair or replacement work that becomes necessary within the warranty period must be approved, as required, and accomplished in a manner so as to restore the integrity of the roof system assembly and validity of the manufacturer warranty for the remainder of the manufacturer warranty period.

PART 2 PRODUCTS

2.1 MATERIALS

Coordinate with other specification sections related to the roof work. Furnish a combination of specified materials that comprise a roof system acceptable to the roof membrane manufacturer and meeting specified requirements. Protect materials provided from defects and make suitable for the service and climatic conditions of the installation.

2.1.1.1 TPO Roof Membrane

Provide Thermoplastic Polyolefin (TPO) complying with ASTM D6878/D6878M; with Internal fabric or scrim reinforced sheet; 80 mils (0.080 inch) thick, minimum; Sheet Width factory fabricated into largest sheets possible; Color, White.

Provide data that includes written acceptance by the roof membrane manufacturer of the insulation and other products and accessories to be provided by and warranted under the full system guarantee of the roof membrane manufacturer.

- a. Coordinate with other specification sections related to the roof work. Furnish a combination of specified materials that comprise a roof system acceptable to the roof membrane manufacturer and meeting specified requirements. Provide materials free of defects and suitable for the service and climatic conditions of the installation. Provide warranted roof system in which all components are sourced from the TPO roof membrane manufacturer, including but not limited to all insulation, coverboards, accessories, adhesives and edge metal.
- b. For each roof, furnish a typewritten information card for facility records and a card laminated in plastic and framed for interior display at roof access point, or a photoengraved 0.032 inch thick aluminum card for exterior display. Provide card that is 8 1/2 by 11 inches minimum. On the information card identify facility name and number; location; contract number; approximate roof area; detailed roof system description, including deck type, membrane, number of plies, method of application, manufacturer, insulation and cover board system and thickness; presence of tapered insulation for primary drainage, presence of vapor retarder; date of completion; installing Contractor identification and contact information; membrane manufacturer warranty expiration, warranty reference number, and contact information. Install card at roof top or access location as directed by the Contracting Officer and provide a paper copy to the Contracting Officer.

2.1.1.2 Energy Star

Provide a roof membrane that is Energy Star labeled. Provide data identifying Energy Star label for roof membrane product.

2.1.1.3 Bonding Adhesive

Provide TPO membrane manufacturer's recommended adhesive, as supplied by roof membrane manufacturer, and recommended by the manufacturer's printed data for bonding of TPO membrane materials to acceptable insulation, wood, metal, concrete or other acceptable substrate materials. Do not use bonding adhesive to bond membrane materials to each other.

2.1.1.4 Seaming Materials:

Provide equipment and material as recommended by the manufacturer to execute hot-air welds. Torching is not permitted.

2.1.1.5 Water Cutoff Mastic/Water Block

As supplied by the roof membrane manufacturer and recommended by the manufacturer's printed data.

2.1.6 Membrane Flashing

Provide waterproof, fully adhered base flashing system at all penetrations, plane transitions, and terminations as recommended and supplied by the roof membrane manufacturer or minimum 0.072 inch thick reinforced TPO roof membrane and flashings. All flashings shall be premolded, corners, boots, etc., and adhered to items to be flashed. Edge metal to be coated for heat welding to membrane. Submit certification from membrane manufacturer that the proposed membrane roofing product meets the minimum polymer thickness specified.

2.1.7 Membrane Fasteners and Plates

Coated, corrosion-resistant fasteners as recommended and supplied by the TPO roof membrane manufacturer and meeting the requirements of FM 4470 and FM RoofNav (www.roofnav.com) or FM APP GUIDE for Class I roof deck construction and the wind uplift resistance specified. Fasteners and plates to be supplied and warranted for the substrate type(s) by TPO membrane manufacturer and recommended by TPO membrane manufacturer's printed data.

2.1.7.1 Stress Plates, Bar or Rail for Fasteners

Utilize corrosion-resistant stress plates as recommended by the roof membrane manufacturer's printed instructions and meeting the requirements of FM 4470. Stress plates to be supplied by TPO roof membrane manufacturer. Form stress plates to prevent dishing or cupping. Manufacturer-supplied anchoring bar or rails may be utilized for high wind conditions.

2.1.7.2 Auxiliary Fasteners

Provide corrosion resistant screws, nails, or anchors suitable for intended attachment purpose and be recommended and supplied for use by the TPO roof membrane manufacturer.

2.1.8 Roof Insulation

Polyisocyanurate (ISO) Board Insulation: Complies with ASTM C1289, Type II, Class 2 - Faced with dark coated-glass facer on one side and light coated-glass facer on other surface of core foam; Grade 2, 20 psi, minimum; 4-1/2 inch minimum thickness. Install tapered insulation and crickets where indicated.

2.1.9 Wood Products

As specified in Section 06 10 00 ROUGH CARPENTRY, except that fire retardant treated materials must not be in contact with TPO membrane or TPO accessory products, unless approved by the membrane manufacturer and the Contracting Officer.

PART 3 EXECUTION

3.1 EXAMINATION

Ensure that the following conditions exist prior to application of the roofing materials:

- a. Do not install items that show visual evidence of biological growth.
- b. Drains, curbs, perimeter walls, roof penetrating components, and equipment supports are in place.
- c. Surfaces are rigid, clean, dry, smooth, and free from cracks, holes, and sharp changes in elevation.
- d. Substrate is sloped to provide positive drainage.
- e. Walls and vertical surfaces are constructed to receive counterflashing, and will permit mechanical fastening of the base flashing materials.
- f. Treated wood nailers are in place on non-nailable surfaces, to permit nailing of base flashing at minimum height of 8 inches above finished roofing surface.
- g. Pressure-preservative treated wood nailers are fastened in place at eaves, gable ends, openings, and intersections with vertical surfaces for securing of membrane, edging strips, attachment flanges of sheet metal, and roof fixtures. Surface-applied nailers are the same thickness as the roof insulation.
- h. TPO materials are not in contact with fire retardant treated wood, except as approved by the TPO membrane roof manufacturer and Contracting Officer.
- i. Exposed nail heads in wood substrates are properly set. Warped and split sheets have been replaced. There are no cracks or end joints 1/4 inch in width or greater. Joints in plywood substrates are taped or otherwise sealed to prevent air leakage from the underside.

3.2 APPLICATION METHOD

Apply entire TPO membrane roofing utilizing adhered or mechanically fastened application methods. Apply roofing materials as specified herein unless approved otherwise by the Contracting Officer. Submit instructions including pattern and frequency of mechanical attachments required in the field for roof, corners, and perimeters to provide for the specified wind resistance

3.2.1 Special Precautions

- a. Do not dilute coatings or sealants unless specifically recommended by the material manufacturer's printed application instructions. Do not thin liquid materials or cleaners used for cleaning TPO sheet.
- b. Keep liquids in airtight containers, and keep containers closed except when removing materials.
- c. Use liquid components, including adhesives, within their shelf life period. Store adhesives at 60 to 80 degrees F prior to use. Avoid excessive adhesive application and adhesive spills, as they can be destructive to some thermoplastic sheets and insulations; follow adhesive manufacturer's printed application instructions. Mix and use liquid components in accordance with label directions and manufacturer's printed instructions.

- d. Provide clean, dry cloths or pads for applying membrane cleaners and cleaning of membrane.
- e. Do not use heat guns or open flame to expedite drying of adhesives or primers.
- f. Require workmen and others who walk on the membrane to wear clean, soft-soled shoes to avoid damage to roofing materials.
- g. Do not use equipment with sharp edges which could puncture the TPO membrane roofing sheet.
- h. Shut down air intakes and any related mechanical systems and seal open vents and air intakes when applying solvent-based materials in the area of the opening or intake. Coordinate shutdowns with the Contracting Officer.

3.2.2 TPO Roofing Membrane

Provide a watertight roof membrane sheet free of contaminants and defects that might affect serviceability. Provide a uniform, straight, and flat edge. Provide membrane overlap of a minimum of 3 inches at sides for adhered applications and 5.5-7 inches for mechanically fastened applications and minimum 4 inches at ends. Direction of laps must allow water to flow over and not against the lap. Install membrane joints that are free of wrinkles and fishmouths. During the day of installation, probe the entire length of hot-air-welded seams and correct any deficiencies. Reweld defective areas. Cut out any fishmouths, or damaged areas and cover the area with membrane using a continuous hot-air-welded seam on all sides. Probe test repairs for continuity. Hot-air-welded seams are to be accomplished in accordance with the TPO membrane roofing manufacturer's published requirements.

3.2.2.1 Nailing

Fasten membrane to nailers in accordance with the membrane manufacturer's approved instructions. Unless otherwise specified, stagger nails on 4 inch centers maximum; stagger screws for sheet metal on 8 inch centers maximum; and install rows of fasteners at least 1/2 inch from edges of sheet metal.

3.2.2.2 Flashing

Flash all roof edges, projections through the roof and changes in roof planes. Seal the seam a minimum of 3 inches beyond the fasteners which attach the membrane to nailers. Secure the installed flashing at the top of the flashing a maximum of 12 inches on centers under the counterflashing or cap. Where possible, install prefabricated components for pipe seals and flashing accessories.

3.2.2.3 Cutoffs

If work is terminated prior to weatherproofing the entire roof, seal the membrane to the roof deck. Also, seal flutes in metal decking along the cutoff edge. Pull the membrane free or cut to expose the insulation when resuming work and remove the cut insulation sheets used for fill-in. Do not use asphalt or coal-tar products for sealing.

3.2.2.4 Walkways

Provide traffic pads around each roof top HVAC unit and where indicated using non-skid compatible material acceptable to roof membrane manufacturer.

3.2.3 Adhered Membrane Application

Layout membrane and side lap adjoining sheets in accordance with membrane manufacturer's printed installation instructions. Allow for sufficient membrane to form proper membrane terminations. Remove dusting agents and dirt from membrane and substrate areas where bonding adhesives are to be applied. Apply specified adhesive evenly and continuously to substrate and underside of sheets at rates recommended by the roof membrane manufacturer's printed application instructions. When adhesive is spray applied, roll with a paint roller to ensure proper contact and coverage. Do not apply bonding adhesive to surfaces of membrane in seam or lap areas. Allow adhesive to flash off or dry to consistency prescribed by manufacturer before adhering sheets to the substrate. When adhesive is peel and stick release paper-activated, follow manufacturer's printed instructions. Roll each sheet into adhesive slowly and evenly to avoid wrinkles; broom or roll the membrane to remove air pockets and fishmouths and to ensure adequately uniform bonding of sheet to substrate. Form field hot-air-welded laps or seams as specified and ensure that hot-air welded dimension is at width required by the membrane manufacturer's installation instructions. Check all seams and continuous hot-air-weld of all seams and lap seals.

3.2.4 Mechanically Fastened Membrane Application

Layout membrane and lap adjoining sheets in accordance with membrane manufacturer's printed instructions such that the minimum recommended seam width is maintained and to ensure that seam width is as required by tested assembly meeting specified wind resistance requirements. Account for additional overlap required for placement of fasteners and plates or battens beyond the closed seam. Allow for sufficient membrane to form proper membrane terminations. Ensure membrane is free of wrinkles and ridges in the installation. Mechanically secure the membrane sheet with specified fasteners in the lap area. Space fasteners as required to provide the wind uplift resistance specified and in accordance with submitted fastener patterns for the field, corner, and perimeter roof areas. Set fasteners firm to plate or batten. Form field hot-air-welded seams, laps and coverstrips, as specified. Check all seams and ensure full/continuous lap seal.

3.2.5 Pre-fabricated Curbs

Securely anchor prefabricated curbs to nailer or other base substrate and flashed with TPO membrane flashing materials.

3.2.5.1 Set-On Accessories

Where pipe or conduit blocking, supports and similar roof accessories, or isolated paver block, are set on the membrane, adhere reinforced membrane or walkpad material, as recommended by the roof membrane manufacturer, to bottom of accessories prior to setting on roofing membrane. Specific method of installing set-on accessories must permit normal movement due to expansion, contraction, vibration, and similar occurrences without damaging roofing membrane. Do not mechanically secure set-on accessories

through roofing membrane into roof deck substrate.

3.3 FLASHINGS

Provide flashings in the angles formed at walls and other vertical surfaces and where required to make the work watertight, except where metal flashings are indicated.

3.3.1 General

Provide a one-ply flashing membrane, as specified for the system used, and install immediately after the roofing membrane is placed and prior to finish coating where a finish coating is required. Flashings must be stepped where vertical surfaces abut sloped roof surfaces. Exposed joints and end laps of flashing membrane must be made and sealed in the manner required for roofing membrane.

3.3.2 Membrane Flashing

3.3.2.1 Installation

Install flashing and flashing accessories as the roof membrane is installed. Apply flashing to cleaned surfaces and as recommended by the roof membrane manufacturer and as specified. Utilize cured TPO membrane flashing and prefabricated accessory flashings to the maximum extent recommended by the roof membrane manufacturer. Limit uncured flashing material to reinforcing inside and outside corners and angle changes in plane of membrane, and to flashing scuppers, pourable sealer pockets, and other formed penetrations or unusually shaped conditions as recommended by the roof membrane manufacturer where the use of cured material is impractical. Extend base flashing not less than 8 inch above roofing surface and as necessary to provide for seaming overlap on roof membrane as recommended by the roof membrane manufacturer.

3.3.2.2 Sealing

Seal flashing membrane for a minimum of 3 inch on each side of fastening device used to anchor roof membrane to nailers. Completely adhere flashing sheets in place. Seam flashing membrane in the same manner as roof membrane, except as otherwise recommended by the membrane manufacturer's printed instructions and approved by the Contracting Officer. Reinforce all corners and angle transitions by applying uncured membrane to the area in accordance with roof membrane manufacturer recommendations. Mechanically fasten top edge of base flashing with manufacturer recommended termination bar fastened at maximum 12 inch on center. Install sheet metal flashing over the termination bar in the completed work. Mechanically fasten top edge of base flashing for all other terminations in a manner recommended by the roof membrane manufacturer. Apply membrane liner over top of exposed nailers and blocking and to overlap top edge of base flashing installation at curbs, parapet walls, expansion joints and as otherwise indicated to serve as waterproof lining under sheet metal flashing components.

3.3.3 Flashing at Roof Drain

Provide a tapered insulation sump into the drain bowl area. Do not exceed tapered slope of 18 degrees for unreinforced membrane and 5 degrees for reinforced membrane. Provide tapered insulation with surface suitable for adhering membrane in the drain sump area. Avoid field seams running

through or within 24 inch of roof drain, or as otherwise recommended by the roof membrane manufacturer. Adhere the membrane to the tapered in the drain sump area. Apply water block mastic and extend membrane sheets over edge of drain bowl opening at the roof drain deck flange in accordance with membrane manufacturer's printed application instructions. Ensure membrane is free of wrinkles and folds in the drain area. Securely clamp membrane in the flashing clamping ring. Ensure membrane is cut to within 3/4 inch of inside rim of clamping ring to maintain drainage capacity. Do not cut back to bolt holes. Retrofit roof drains must conform to ANSI/SPRI RD-1.

3.4 ROOF WALKPADS

Install walkpads at roof access points and where otherwise indicated for traffic areas and for access to mechanical equipment, in accordance with the roof membrane manufacturer's printed instructions. Provide minimum 6 inch separation between adjacent walkpads to accommodate drainage.

3.5 CORRECTION OF DEFICIENCIES

Where any form of deficiency is found, take additional measures as deemed necessary by the Contracting Officer to determine the extent of the deficiency and provide corrective action recommendations. Perform corrective action as directed by the Contracting Officer.

3.6 PROTECTION OF APPLIED ROOFING

At the end of the day's work and when precipitation is imminent, protect applied membrane roofing system from water intrusion.

3.6.1 Water Cutoffs

Straighten insulation line using loose-laid cut insulation sheets and seal the terminated edge of the roof membrane system in an effective manner. Remove the water cut-offs to expose the insulation when resuming work, and remove the insulation sheets used for fill-in.

3.6.2 Temporary Flashing for Permanent Roofing

Provide temporary flashing at drains, curbs, walls and other penetrations and terminations of roofing sheets until permanent flashings can be applied. Remove temporary flashing before applying permanent flashing.

3.6.3 Temporary Walkways, Runways, and Platforms

Do not permit storing, walking, wheeling, and trucking directly on applied roofing system. Provide temporary walkways, runways, and platforms of smooth clean boards, mats or planks as necessary to avoid damage to applied roofing materials, and to distribute weight to conform to live load limits of roof construction. Use rubber-tired equipment for roofing work.

3.7 FIELD QUALITY CONTROL

3.7.1 Construction Monitoring

During progress of the roof work, make visual inspections as necessary to ensure compliance with specified parameters. Additionally, verify the following:

- a. Equipment is in working order. Metering devices are accurate.
- b. Materials are not installed in adverse weather conditions.
- c. Substrates are in acceptable condition, in compliance with specification, prior to application of subsequent materials.
 - (1) Nailers and blocking are provided where and as needed.
 - (2) Insulation substrate is smooth, properly secured to its substrate, and without excessive gaps prior to membrane application.
 - (3) The proper number, type, and spacing of fasteners are installed.
 - (4) Materials comply with the specified requirements.
 - (5) All materials are properly stored, handled and protected from moisture or other damages. Liquid components are properly mixed prior to application.
 - (6) Adhesives are applied uniformly to both mating surfaces and checked for proper set prior to bonding mating materials. Mechanical attachments are spaced as required, including additional fastening of membrane in corner and perimeter areas as required.
 - (7) Membrane is properly overlapped.
 - (8) Membrane seaming is as specified by TPO membrane manufacturer. All seams are checked at the end of each work day.
 - (9) Applied membrane is inspected and repaired as necessary prior to paver installation.
 - (10) Membrane is adhered without ridges, wrinkles, kinks, fishmouths.
 - (11) Installer adheres to specified and detailed application parameters.
 - (12) Associated flashing's and sheet metal are installed in a timely manner in accord with the specified requirements.
 - (13) Temporary protection measures are in place at the end of each work shift.

3.7.2 Manufacturer's Inspection

Manufacturer's technical representative must be present full time when Single Source Contract Liability Warranty is desired during the installation for purposes of reviewing materials installation practices and adequacy of work in place. After each inspection, a report, signed by the manufacturer's technical representative to the roofing Contractor and then to the Contracting Officer within 3 working days. Within the report state the overall quality of work, deficiencies and any other concerns, and recommended corrective action.

3.8 CLEAN UP

Remove debris, scraps, containers and other rubbish and trash resulting from installation of the roofing system from job site each day.

3.9 INSTRUCTIONS TO GOVERNMENT PERSONNEL

Furnish written and verbal instructions on proper maintenance procedures to designated Government personnel. Furnish instructions by a competent representative of the roof membrane manufacturer and include a minimum of 4 hours on maintenance and emergency repair of the membrane. Include a demonstration of membrane repair, and give sources of required special tools. Furnish information on safety requirements during maintenance and emergency repair operations. Include copies of Safety Data Sheets for maintenance/repair materials.

-- End of Section --

SECTION 07 84 00

FIRESTOPPING

05/10, CHG 1: 08/13

PART 1 GENERAL

1.1 SUMMARY

Furnish and install tested and listed firestopping systems, combination of materials, or devices to form an effective barrier against the spread of flame, smoke and gases, and maintain the integrity of fire resistance rated walls, partitions, floors, and ceiling-floor assemblies, including through-penetrations and construction joints and gaps.

- a. Through-penetrations include the annular space around pipes, tubes, conduit, wires, cables and vents.
- b. Construction joints include those used to accommodate expansion, contraction, wind, or seismic movement; do not allow firestopping material to interfere with the required movement of the joint.
- c. Gaps requiring firestopping include gaps between the curtain wall and the floor slab and between the top of the fire-rated walls and the roof or floor deck above and at the intersection of shaft assemblies and adjoining fire resistance rated assemblies.

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM E84	(2020) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM E119	(2022) Standard Test Methods for Fire Tests of Building Construction and Materials
ASTM E699	(2009) Standard Practice for Evaluation of Agencies Involved in Testing, Quality Assurance, and Evaluating of Building Components
ASTM E814	(2013a; R 2017) Standard Test Method for Fire Tests of Penetration Firestop Systems
ASTM E1399/E1399M	(1997; R 2022) Standard Test Method for Cyclic Movement and Measuring the Minimum and Maximum Joint Widths of Architectural Joint Systems
ASTM E1966	(2015; R 2019) Standard Test Method for Fire-Resistive Joint Systems

ASTM E2174	(2020a) Standard Practice for On-Site Inspection of Installed Firestop Systems
ASTM E2307	(2020) Standard Test Method for Determining Fire Resistance of Perimeter Fire Barrier Systems Using Intermediate-Scale, Multi-story Test Apparatus
ASTM E2393	(2020a) Standard Practice for On-Site Inspection of Installed Fire Resistive Joint Systems and Perimeter Fire Barriers
FM GLOBAL (FM)	
FM 4991	(2013) Approval of Firestop Contractors
FM APP GUIDE	(updated on-line) Approval Guide http://www.approvalguide.com/
UNDERWRITERS LABORATORIES (UL)	
UL 723	(2018) UL Standard for Safety Test for Surface Burning Characteristics of Building Materials
UL 1479	(2015; Reprint May 2021) Fire Tests of Through-Penetration Firestops
UL 2079	(2015; Reprint Jul 2020) Tests for Fire Resistance of Building Joint Systems
UL Fire Resistance	(2014) Fire Resistance Directory

1.3 SEQUENCING

Coordinate the specified work with other trades. Apply firestopping materials, at penetrations of pipes and ducts, prior to insulating, unless insulation meets requirements specified for firestopping. Apply firestopping materials, at building joints and construction gaps, prior to completion of enclosing walls or assemblies. Firestop material must be inspected and approved prior to final completion and enclosing of any assemblies that may conceal installed firestop.

1.4 SUBMITTALS

Government approval is required for submittals . Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Firestopping System

SD-03 Product Data

Firestopping Materials

SD-06 Test Reports

Inspection

SD-07 Certificates

Firestopping Materials

Installer Qualifications

Inspector Qualifications

1.5 QUALITY ASSURANCE

1.5.1 Installer

Engage an experienced Installer who is:

- a. FM Research approved in accordance with FM 4991, operating as a UL Certified Firestop Contractor, or
- b. Certified, licensed, or otherwise qualified by the firestopping manufacturer as having the necessary staff, training, and a minimum of 3 years experience in the installation of manufacturer's products in accordance with specified requirements. Submit documentation of this experience. A manufacturer's willingness to sell its firestopping products to the Contractor or to an installer engaged by the Contractor does not in itself confer installer qualifications on the buyer. The Installer must be a trained representative of the manufacturer (not distributor or agent) in the proper selection and installation procedures. Obtain and submit installer's written certification of training, and retain proof of certification for duration of firestop installation.

1.5.2 Inspector Qualifications

The inspector must meet the criteria contained in ASTM E699 for agencies involved in quality assurance and must have a minimum of two years experience in construction field inspections of firestopping systems, products, and assemblies. The inspector must be completely independent of, and divested from, the installer, the manufacturer, and the supplier of any material or item being inspected. The inspector must not be a competitor of the installer, the contractor, the manufacturer, or supplier of any material or item being inspected. Include in the qualifications submittal a notarized statement assuring compliance with the requirements stated herein.

1.6 DELIVERY, STORAGE, AND HANDLING

Deliver materials in the original unopened packages or containers showing name of the manufacturer and the brand name. Store materials off the ground, protected from damage and exposure to elements and temperatures in accordance with manufacturer requirements. Remove damaged or deteriorated materials from the site. Use materials within their indicated shelf life.

PART 2 PRODUCTS

2.1 FIRESTOPPING SYSTEM

Submit detail drawings including manufacturer's descriptive data, typical

details conforming to **UL Fire Resistance** or other details certified by another nationally recognized testing laboratory, installation instructions or UL listing details for a firestopping assembly in lieu of fire-test data or report. For those firestop applications for which no UL tested system is available through a manufacturer, submit a manufacturer's engineering judgment, derived from similar UL system designs or other tests for review and approval prior to installation. Submittal must indicate the firestopping material to be provided for each type of application. When more than a total of 5 penetrations and/or construction joints are to receive firestopping, provide drawings that indicate location, "F" "T" and "L" ratings, and type of application.

Also, submit a written report indicating locations of and types of penetrations and types of firestopping used at each location; record type by UL list printed numbers.

2.2 FIRESTOPPING MATERIALS

Provide firestopping materials, supplied from a single domestic manufacturer, consisting of commercially manufactured, asbestos-free, nontoxic products **FM APP GUIDE** approved, or UL listed, for use with applicable construction and penetrating items, complying with the following minimum requirements:

2.2.1 Fire Hazard Classification

Provide material that has a flame spread of 25 or less, and a smoke developed rating of 50 or less, when tested in accordance with **ASTM E84** or **UL 723**. Provide an approved firestopping material as listed in **UL Fire Resistance** or by a nationally recognized testing laboratory.

2.2.2 Toxicity

Provide material that is nontoxic and carcinogen free to humans at all stages of application or during fire conditions and does not contain hazardous chemicals or require harmful chemicals to clean material or equipment.

2.2.3 Fire Resistance Rating

Firestop systems must be **UL Fire Resistance** listed or **FM APP GUIDE** approved with "F" rating at least equal to fire-rating of fire wall or floor in which penetrated openings are to be protected. Where required, firestop systems must also have "T" rating at least equal to the fire-rated floor in which the openings are to be protected.

2.2.3.1 Through-Penetrations

Firestopping materials for through-penetrations, as described in paragraph SUMMARY, must provide "F", "T" and "L" fire resistance ratings in accordance with **ASTM E814** or **UL 1479**. Provide fire resistance ratings as follows:

2.2.3.1.1 Penetrations of Fire Resistance Rated Walls and Partitions

F Rating = Rating of wall or partition being penetrated.

2.2.3.2 Construction Joints and Gaps

Fire resistance ratings of construction joints, as described in paragraph SUMMARY, and gaps such as those between floor slabs and curtain walls must be the same as the construction in which they occur. Provide construction joints and gaps with firestopping materials and systems that have been tested in accordance with ASTM E119, ASTM E1966 or UL 2079 to meet the required fire resistance rating. Provide curtain wall joints with firestopping materials and systems that have been tested in accordance with ASTM E2307 to meet the required fire resistance rating. Systems installed at construction joints must meet the cycling requirements of ASTM E1399/E1399M or UL 2079. Provide a minimum class II movement capability for all joints at the intersection of the top of a fire resistance rated wall and the underside of a fire-rated floor, floor ceiling, or roof ceiling assembly.

2.2.4 Material Certification

Submit certificates attesting that firestopping material complies with the specified requirements. Provide certification of compliance with UL 1479 for all intumescent firestop materials used in through penetration systems.

PART 3 EXECUTION

3.1 PREPARATION

Areas to receive firestopping must be free of dirt, grease, oil, or loose materials which may affect the fitting or fire resistance of the firestopping system. For cast-in-place firestop devices, formwork or metal deck to receive device prior to concrete placement must be sound and capable of supporting device. Prepare surfaces as recommended by the manufacturer.

3.2 INSTALLATION

Completely fill void spaces with firestopping material regardless of geometric configuration, subject to tolerance established by the manufacturer. Firestopping systems for filling floor voids 4 inches or more in any direction must be capable of supporting the same load as the floor is designed to support or be protected by a permanent barrier to prevent loading or traffic in the firestopped area. Install firestopping in accordance with manufacturer's written instructions. Provide tested and listed firestop systems in the following locations, except in floor slabs on grade:

- a. Penetrations of duct, conduit, tubing, cable and pipe through floors and through fire-resistance rated walls, partitions, and ceiling-floor assemblies.
- b. Penetrations of vertical shafts such as pipe chases, elevator shafts, and utility chutes.
- c. Gaps at the intersection of floor slabs and curtain walls, including inside of hollow curtain walls at the floor slab.
- d. Gaps at perimeter of fire-resistance rated walls and partitions, such as between the top of the walls and the bottom of roof decks.
- e. Construction joints in floors and fire rated walls and partitions.

- f. Other locations where required to maintain fire resistance rating of the construction.

3.2.1 Insulated Pipes and Ducts

Cut and remove thermal insulation where pipes or ducts pass through firestopping, unless insulation meets requirements specified for firestopping. Replace thermal insulation with a material having equal thermal insulating and firestopping characteristics.

3.2.2 Fire Dampers

Install and firestop fire dampers in accordance with Section 23 30 00 HVAC AIR DISTRIBUTION. Firestop installed with fire damper must be tested and approved for use in fire damper system. Firestop installed with fire damper must be tested and approved for use in fire damper system.

3.2.3 Data and Communication Cabling

Seal cabling for data and communication applications with re-enterable firestopping products.

3.2.3.1 Re-Sealable Products

Provide firestopping pre-manufactured modular products, containing self-sealing intumescent inserts. Allow for cable moves, additions or changes. Provide devices capable of maintaining the fire resistance rating of the penetrated membrane at 0 percent to 100 percent visual fill of penetrants.

3.3 IDENTIFICATION OF FIRE WALLS:

In accordance with IBC, clearly mark all corridor partitions, smoke walls and firewalls above the ceiling with stenciled or hand lettering at least 1" high and reading "Fire and Smoke Barrier - Protect all Openings". Such identification shall occur on both sides of walls at a spacing not to exceed 25 feet, and at least once on any such wall in a given room regardless of length.

3.4 INSPECTION

For all projects, do not cover or enclose the firestopped areas until inspection is complete and approved by the Contracting Officer. Inspect the applications initially to ensure adequate preparations (clean surfaces suitable for application, etc.) and periodically during the work to assure that the completed work has been accomplished according to the manufacturer's written instructions and the specified requirements. Submit written reports indicating locations of and types of penetrations and types of firestopping used at each location; record type by UL listed printed numbers.

3.4.1 Inspection Standards

Inspect all firestopping in accordance with ASTM E2393 and ASTM E2174 for firestop inspection, and document inspection results to be submitted.

3.4.2 Inspection Reports

Submit inspection report stating that firestopping work has been inspected and found to be applied according to the manufacturer's recommendations and the specified requirements.

-- End of Section --

SECTION 07 92 00

JOINT SEALANTS
08/16, CHG 3: 11/18

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM C734	(2015; R 2019) Low-Temperature Flexibility of Latex Sealants After Artificial Weathering
ASTM C919	(2022) Standard Practice for Use of Sealants in Acoustical Applications
ASTM C920	(2018) Standard Specification for Elastomeric Joint Sealants
ASTM C1193	(2013) Standard Guide for Use of Joint Sealants
ASTM C1521	(2013) Standard Practice for Evaluating Adhesion of Installed Weatherproofing Sealant Joints
ASTM D217	(2019b) Standard Test Methods for Cone Penetration of Lubricating Grease
ASTM D1056	(2020) Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber
ASTM E84	(2020) Standard Test Method for Surface Burning Characteristics of Building Materials

CALIFORNIA DEPARTMENT OF PUBLIC HEALTH (CDPH)

CDPH SECTION 01350	(2010; Version 1.1) Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources using Environmental Chambers

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT (SCAQMD)

SCAQMD Rule 1168	(2017) Adhesive and Sealant Applications

1.2 SUBMITTALS

Government approval is required for submittals . Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Sealants

Primers

Bond Breakers

Backstops

SD-06 Test Reports

Field Adhesion

SD-07 Certificates

Indoor Air Quality For Interior Sealants

Indoor Air Quality For Interior Acoustical Sealants

1.3 PRODUCT DATA

Include storage requirements, shelf life, curing time, instructions for mixing and application, and accessories. Provide manufacturer's Safety Data Sheets (SDS) for each solvent, primer and sealant material proposed.

1.4 ENVIRONMENTAL CONDITIONS

Apply sealant when the ambient temperature is between 40 and 90 degrees F.

1.5 DELIVERY AND STORAGE

Deliver materials to the jobsite in unopened manufacturers' sealed shipping containers, with brand name, date of manufacture, color, and material designation clearly marked thereon. Label elastomeric sealant containers to identify type, class, grade, and use. Handle and store materials in accordance with manufacturer's printed instructions. Prevent exposure to foreign materials or subjection to sustained temperatures exceeding 90 degrees F or lower than 0 degrees F. Keep materials and containers closed and separated from absorptive materials such as wood and insulation.

1.6 QUALITY ASSURANCE

1.6.1 Compatibility with Substrate

Verify that each sealant is compatible for use with each joint substrate in accordance with sealant manufacturer's printed recommendations for each application.

1.6.2 Joint Tolerance

Provide joint tolerances in accordance with manufacturer's printed instructions.

1.6.3 Mock-Up

Provide a mock-up of each type of sealant using materials, colors, and

techniques approved for use on the project. Approved mock-ups may be incorporated into the Work.

1.6.4 Adhesion

Provide in accordance with [ASTM C1193](#) or [ASTM C1521](#).

PART 2 PRODUCTS

2.1 SEALANTS

Provide sealant products that have been tested, found suitable, and documented as such by the manufacturer for the particular substrates to which they will be applied.

2.1.1 Interior Sealants

Provide [ASTM C920](#), Type S or M, Grade NS, Class 12.5, Use NT. Provide [acrylic](#) sealant products used on the interior of the building (defined as inside of the weatherproofing system) meeting either emissions requirements of [CDPH SECTION 01350](#) (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of [SCAQMD Rule 1168](#). Provide certification or validation of [indoor air quality for interior sealants](#). Location(s) and color(s) of sealant for the following. [Color as required to match adjacent surfaces](#).

LOCATION
a. Small voids between walls or partitions and adjacent lockers, casework, shelving, door frames, built-in or surface mounted equipment and fixtures, and similar items.
b. Perimeter of frames at doors, windows, and access panels which adjoin exposed interior concrete and masonry surfaces.
c. Joints of interior masonry walls and partitions which adjoin columns, pilasters, concrete walls, and exterior walls unless otherwise detailed.
d. Joints between edge members for acoustical tile and adjoining vertical surfaces.
e. Interior locations, not otherwise indicated or specified, where small voids exist between materials specified to be painted.
f. Joints between bathtubs and ceramic tile; joints between shower receptors and ceramic tile; joints formed where non-planar tile surfaces meet.
g. Joints formed between tile floors and tile base cove; joints between tile and dissimilar materials; joints occurring where substrates change.

LOCATION
h. Behind escutcheon plates at valve pipe penetrations and showerheads in showers.

2.1.2 Exterior Sealants

For joints in vertical surfaces, provide **ASTM C920**, Type S or M, Grade NS, Class 25, Use NT. For joints in horizontal surfaces, provide **ASTM C920**, Type S or M, Grade P, Class 25, Use T. Provide location(s) and color(s) of sealant as follows. **Color as required to match adjacent surfaces.**

LOCATION
a. Joints and recesses formed where frames and subsills of windows, doors, louvers, and vents adjoin masonry, concrete, or metal frames. Use sealant at both exterior and interior surfaces of exterior wall penetrations.
b. Joints between new and existing exterior masonry walls.
c. Masonry joints where shelf angles occur.
d. Joints in wash surfaces of stonework.
e. Expansion and control joints.
f. Interior face of expansion joints in exterior concrete or masonry walls where metal expansion joint covers are not required.
g. Voids where items pass through exterior walls.
h. Metal reglets, where flashing is inserted into masonry joints, and where flashing is penetrated by coping dowels.
i. Metal-to-metal joints where sealant is indicated or specified.
j. Joints between ends of gravel stops, fascia, copings, and adjacent walls.

2.1.3 Floor Joint Sealants

ASTM C920, Type S or M, Grade P, Class 25, Use T. **Multicomponent**

polyurethane, self-leveling. Provide sealant products used on the interior of the building (defined as inside of the weatherproofing system) meeting either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of SCAQMD Rule 1168. Provide location(s) and color(s) of sealant as follows. Color to match adjacent surfaces.

LOCATION
a. Seats of metal thresholds for exterior doors.
b. Control and expansion joints in floors, slabs, ceramic tile, and walkways.

2.1.4 Acoustical Sealants

Rubber or polymer based acoustical sealant in accordance with ASTM C919 to have a flame spread of 25 or less and a smoke developed rating of 50 or less when tested in accordance with ASTM E84. Provide non-staining acoustical sealant with a consistency of 250 to 310 when tested in accordance with ASTM D217. Acoustical sealant must remain flexible and adhesive after 500 hours of accelerated weathering as specified in ASTM C734. Provide sealant products used on the interior of the building (defined as inside of the weatherproofing system) meeting either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of SCAQMD Rule 1168. Provide certification or validation of indoor air quality for interior acoustical sealants.

2.2 PRIMERS

Non-staining, quick drying type and consistency as recommended by the sealant manufacturer for the particular application. Provide primers for interior applications that meet the indoor air quality requirements of the paragraph SEALANTS above.

2.3 BOND BREAKERS

Type and consistency as recommended by the sealant manufacturer to prevent adhesion of the sealant to the backing or to the bottom of the joint. Provide bond breakers for interior applications that meet the indoor air quality requirements of the paragraph SEALANTS above.

2.4 BACKSTOPS

Provide neoprene, polyurethane, or polyethylene foams free from oil or other staining elements as recommended by sealant manufacturer. Provide 25 to 33 percent oversized backing for closed cell and 40 to 50 percent oversized backing for open cell material, unless otherwise indicated. Provide backstop material that is compatible with sealant. Do not use oakum or other types of absorptive materials as backstops.

2.4.1 Neoprene

Provide in accordance with ASTM D1056, open cell neoprene sponge Type 1,

Class C, Grade 1C3 for neoprene backing.

2.4.2 Silicone Rubber Base

Provide in accordance with ASTM C920, from a single component, with solvent release, Non-sag, . Color as selected from manufacturer's full range of color choices.

2.5 CLEANING SOLVENTS

Provide type(s) recommended by the sealant manufacturer and in accordance with environmental requirements herein. Protect adjacent aluminum and bronze surfaces from solvents. Provide solvents for interior applications that meet the indoor air quality requirements of the paragraph SEALANTS above.

PART 3 EXECUTION

3.1 FIELD QUALITY CONTROL

Perform a field adhesion test in accordance with manufacturer's instructions and [ASTM C1193](#), Method A or ASTM C1521, Method A, Tail Procedure. Remove sealants that fail adhesion testing; clean substrates, reapply sealants, and re-test. Test sealants adjacent to failed sealants. Submit [field adhesion](#) test report indicating tests, locations, dates, results, and remedial actions taken.

3.2 EXAMINATION

3.2.1 Previously Caulked Joint Preparation:

Determine type(s) of existing caulking compounds which have been previously employed, perform adhesion test. Submit and follow new sealant manufacturer's recommendations regarding compatibility, priming, stripping of old compound or sealant. In any case strip away old material so as to obtain a firm seat for new material, to open and clear caulking grooves.

Thereafter, proceed generally as specified for sealing of new joints.

3.3 SURFACE PREPARATION

Prepare surfaces according to manufacturer's printed installation instructions. Clean surfaces from dirt, frost, moisture, grease, oil, wax, lacquer, paint, or other foreign matter that would destroy or impair adhesion. Remove oil and grease with solvent; thoroughly remove solvents prior to sealant installation. Wipe surfaces dry with clean cloths. When resealing an existing joint, remove existing caulk or sealant prior to applying new sealant. For surface types not listed below, provide in accordance with sealant manufacturer's printed instructions for each specific surface.

3.3.1 Steel Surfaces

Remove loose mill scale by sandblasting or, if sandblasting is impractical or would damage finished work, scraping and wire brushing. Remove protective coatings by sandblasting or using a residue free solvent. Remove resulting debris and solvent residue prior to sealant installation.

3.3.2 Aluminum Surfaces

Remove temporary protective coatings from surfaces that will be in contact with sealant. When masking tape is used as a protective coating, remove tape and any residual adhesive prior to sealant application. For removing protective coatings and final cleaning, use non-staining solvents recommended by the manufacturer of the item(s) containing aluminum or bronze surfaces.

3.3.3 Concrete and Masonry Surfaces

Where surfaces have been treated with curing compounds, oil, or other such materials, remove materials by sandblasting or wire brushing. Remove laitance, efflorescence and loose mortar from the joint cavity. Remove resulting debris prior to sealant installation.

3.3.4 Wood Surfaces

Ensure wood surfaces that will be in contact with sealants are free of splinters, sawdust and other loose particles.

3.4 SEALANT PREPARATION

Do not add liquids, solvents, or powders to sealants. Mix multicomponent elastomeric sealants in accordance with manufacturer's printed instructions.

3.5 APPLICATION

3.5.1 Joint Width-To-Depth Ratios

Acceptable Ratios:

<u>JOINT WIDTH</u>	<u>JOINT DEPTH</u>	
	Minimum	Maximum
For metal, glass, or other nonporous surfaces:		
1/4 inch (minimum)	1/4 inch	1/4 inch
over 1/4 inch	1/2 of width	Equal to width
For wood, concrete, masonry, stone, or Gypsum		
1/4 inch (minimum)	1/4 inch	1/4 inch
over 1/4 inch to 1/2 inch	1/4 inch	Equal to width
over 1/2 inch to 1 inch	1/2 inch	5/8 inch
Over 1 inch	prohibited	

Unacceptable Ratios: Where joints of acceptable width-to-depth ratios have not been provided, clean out joints to acceptable depths and grind or cut to acceptable widths without damage to the adjoining work. Grinding is prohibited at metal surfaces.

3.5.2 Unacceptable Sealant Use

Do not install sealants in lieu of other required building enclosure weatherproofing components such as flashing, drainage components, and joint closure accessories, or to close gaps between walls, floors, roofs, windows, and doors, that exceed acceptable installation tolerances. Remove sealants that have been used in an unacceptable manner and correct building enclosure deficiencies to comply with contract documents requirements.

3.5.3 Masking Tape

Place masking tape on the finished surface on one or both sides of joint cavities to protect adjacent finished surfaces from primer or sealant smears. Remove masking tape within 10 minutes of joint filling and tooling.

3.5.4 Backstops

Provide backstops dry and free of tears or holes. Tightly pack the back or bottom of joint cavities with backstop material to provide joints in specified depths. Provide backstops where indicated and where backstops are not indicated but joint cavities exceed the acceptable maximum depths specified in JOINT WIDTH-TO-DEPTH RATIOS Table.

3.5.5 Primer

Clean out loose particles from joints immediately prior to application of. Apply primer to joints in concrete masonry units, wood, and other porous surfaces in accordance with sealant manufacturer's printed instructions. Do not apply primer to exposed finished surfaces.

3.5.6 Bond Breaker

Provide bond breakers to surfaces not intended to bond in accordance with, sealant manufacturer's printed instructions for each type of surface and sealant combination specified.

3.5.7 Sealants

Provide sealants compatible with the material(s) to which they are applied. Do not use a sealant that has exceeded its shelf life or has jelled and cannot be discharged in a continuous flow from the sealant gun. Apply sealants in accordance with the manufacturer's printed instructions with a gun having a nozzle that fits the joint width. Work sealant into joints so as to fill the joints solidly without air pockets. Tool sealant after application to ensure adhesion. Apply sealant uniformly smooth and free of wrinkles. Upon completion of sealant application, roughen partially filled or unfilled joints, apply additional sealant, and tool smooth as specified. Apply sealer over sealants in accordance with the sealant manufacturer's printed instructions.

3.6 PROTECTION AND CLEANING

3.6.1 Protection

Protect areas adjacent to joints from sealant smears. Masking tape may be used for this purpose if removed 5 to 10 minutes after the joint is filled

and no residual tape marks remain.

3.6.2 Final Cleaning

Upon completion of sealant application, remove remaining smears and stains and leave the work in a clean and neat condition.

- a. Masonry and Other Porous Surfaces: Immediately remove fresh sealant that has been smeared on adjacent masonry, rub clean with a solvent, and remove solvent residue, in accordance with sealant manufacturer's printed instructions. Allow excess sealant to cure for 24 hour then remove by wire brushing or sanding. Remove resulting debris.
- b. Metal and Other Non-Porous Surfaces: Remove excess sealant with a solvent moistened cloth. Remove solvent residue in accordance with solvent manufacturer's printed instructions.

-- End of Section --

SECTION 08 11 13

STEEL DOORS AND FRAMES
08/20

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M (2020; Errata 1 2021) Structural Welding
Code - Steel

ASTM INTERNATIONAL (ASTM)

ASTM A653/A653M (2022) Standard Specification for Steel
Sheet, Zinc-Coated (Galvanized) or
Zinc-Iron Alloy-Coated (Galvannealed) by
the Hot-Dip Process

ASTM A879/A879M (2012; R 2017) Standard Specification for
Steel Sheet, zinc Coated by the
Electrolytic Process for Applications
Requiring Designation of the Coating Mass
on Each Surface

ASTM A924/A924M (2022a) Standard Specification for General
Requirements for Steel Sheet,
Metallic-Coated by the Hot-Dip Process

ASTM C578 (2022) Standard Specification for Rigid,
Cellular Polystyrene Thermal Insulation

ASTM C612 (2014; R 2019) Standard Specification for
Mineral Fiber Block and Board Thermal
Insulation

ASTM E1300 (2016) Standard Practice for Determining
Load Resistance of Glass in Buildings

ASTM F2248 (2012) Standard Practice for Specifying an
Equivalent 3-Second Duration Design
Loading for Blast Resistant Glazing
Fabricated with Laminated Glass

BUILDERS HARDWARE MANUFACTURERS ASSOCIATION (BHMA)

ANSI/BHMA A156.115 (2016) Hardware Preparation in Steel Doors
and Steel Frames

NATIONAL ASSOCIATION OF ARCHITECTURAL METAL MANUFACTURERS (NAAMM)

NAAMM HMM 810 (2009) Hollow Metal Doors

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 80 (2022) Standard for Fire Doors and Other
Opening Protectives

NFPA 252 (2022) Standard Methods of Fire Tests of
Door Assemblies

STEEL DOOR INSTITUTE (SDI/DOOR)

SDI/DOOR 111 (2009) Recommended Details for Standard
Steel Doors, Frames, and Accessories and
Related Components

SDI/DOOR 113 (2013; R2018) Standard Practice for
Determining the Steady-State Thermal
Transmittance of Steel Door and Frame
Assemblies

SDI/DOOR A250.4 (2018) Test Procedure and Acceptance
Criteria for Physical Endurance for Steel
Doors, Frames and Frame Anchors

SDI/DOOR A250.6 (2015) Recommended Practice for Hardware
Reinforcing on Standard Steel Doors and
Frames

SDI/DOOR A250.8 (2017) Specifications for Standard Steel
Doors and Frames

SDI/DOOR A250.11 (2012) Recommended Erection Instructions
for Steel Frames

UNDERWRITERS LABORATORIES (UL)

UL 10C (2016; Reprint May 2021) UL Standard for
Safety Positive Pressure Fire Tests of
Door Assemblies

1.2 SUBMITTALS

Government approval is required for submittals . Submit the following in
accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Doors

Frames

Accessories

Schedule of Doors

Schedule of Frames

SD-03 Product Data

Doors

Recycled Content for Steel Door Product

Frames

Recycled Content for Steel Frame Product

Accessories

1.3 DELIVERY, STORAGE, AND HANDLING

Deliver doors, frames, and accessories undamaged and with protective wrappings or packaging. Provide temporary steel spreaders securely fastened to the bottom of each welded frame. Store doors and frames on platforms under cover in clean, dry, ventilated, and accessible locations, with 1/4 inch airspace between doors. Remove damp or wet packaging immediately and wipe affected surfaces dry. Replace damaged materials with new.

PART 2 PRODUCTS

2.1 REQUIREMENTS FOR ALL DOORS AND FRAMES:

2.1.1 Steel Sheet:

Comply with one or more of the following requirements; galvanized steel complying with ASTM A653/A653M, cold-rolled steel complying with ASTM A1008/A1008M, or hot-rolled pickled and oiled (HRPO) steel complying with ASTM A1011/A1011M, commercial steel (CS) Type B, for each; unless indicated otherwise.

2.1.2 Door Top Closures:

Flush end closure channel, with top and door faces aligned.

2.1.3 Door Edge Profile:

Beveled, both sides.

2.1.4 Typical Door Face Sheets

Flush; The vertical edge welds to be ground and polished smooth invisible.

2.1.5 Glazed Lights

Non-removable stops on non-secure side; sizes and configurations as indicated on drawings.

2.1.6 Hardware Preparation

In accordance with BHMA A156.115, with reinforcement welded in place, in addition to other requirements specified in door grade standard.

2.2 STANDARD STEEL DOORS

SDI/DOOR A250.8, except as specified otherwise. Prepare doors to receive door hardware as specified in Section 08 71 00 DOOR HARDWARE. Undercut where indicated. Provide exterior doors with top edge closed flush and

sealed to prevent water intrusion. Provide doors at 1-3/4 inch thick, unless otherwise indicated. Provide door material that uses a minimum of 25 percent recycled content. Provide data indicating percentage of recycled content for steel door product. Provide exterior glazing in accordance with ASTM E1300.

2.2.1 Classification - Level, Performance, Model

2.2.1.1 Standard Duty Doors

SDI/DOOR A250.8, Level 1, physical performance Level C, Model 1, of size(s) and design(s) indicated and core construction as required by the manufacturer. Provide where shown.

2.2.1.2 Heavy Duty Doors

SDI/DOOR A250.8, Level 2, physical performance Level B, Model 1, with core construction as required by the manufacturer for interior doors, of size(s) and design(s) indicated.

2.3 IMPACT TRAFFIC DOOR

Provide stainless steel doors as indicated; 16-gauge stainless steel door with #4 brush finish, 36 inch high 18-gage stainless steel kick plate both sides, 9 inch x 14 inch light with 1/4 inch acrylic glass set in black rubber molding, and self-closing, double-acting gravity hinges hidden in black spine. Include unpainted 16-gage Type 302 stainless steel frame with #4 finish complete with suitable anchors.

2.4 CUSTOM HOLLOW METAL DOORS

Provide custom hollow metal doors where nonstandard steel doors are indicated. Provide custom steel doors in the door size(s), design(s), materials, construction, gages, and finish as specified for custom steel doors and complying with the requirements of NAAMM HMMA 810. Fill all spaces in exterior doors with insulation. Close top and bottom edges with steel channels not lighter than 16 gage. Close tops of exterior doors flush with an additional channel and seal to prevent water intrusion. Prepare doors to receive hardware specified in Section 08 71 00 DOOR HARDWARE. Undercut doors where indicated. Provide doors at 1-3/4 inch thick, unless otherwise indicated. Provide exterior glazing in accordance with ASTM F2248 and ASTM E1300.

2.5 INSULATED STEEL DOOR SYSTEMS

Provide insulated steel doors and frames in accordance with SDI/DOOR 113 where indicated. Meet energy requirements including Solar Heat Gain Coefficient (SHGC) and U-factor. Provide insulated steel doors with a core of polyurethane foam; face sheets, edges, and frames of galvanized steel not lighter than 23 gage, 16 gage, and 16 gage respectively; magnetic weatherstripping; nonremovable-pin hinges; thermal-break aluminum threshold; and vinyl door bottom. Provide to doors and frames a phosphate treatment, rust-inhibitive primer, and baked acrylic enamel finish. Test doors in accordance with SDI/DOOR A250.4 and meet the requirements for Level C. Prepare doors to receive specified hardware. Provide doors 1-3/4 inch thick.

2.6 ACCESSORIES

2.6.1 Louvers

2.6.1.1 Exterior Louvers

Provide louvers of the inverted "Y""V" type with minimum of 55 percent net-free opening. Weld or tenon louver blades to continuous channel frame and weld assembly to door to form watertight assembly. Form louvers of hot-dip galvanized steel of same gage as door facings. At louvers provide steel-framed insect screens secured to room side and readily removable. Provide aluminum wire cloth, 18 by 18 or 18 by 16 inch mesh, for insect screens. Net-free louver area to be before screening.

2.6.2 Astragals

For pairs of exterior steel doors which will not have aluminum astragals or removable mullions, as specified in Section 08 71 00 DOOR HARDWARE provide overlapping steel astragals with the doors.

Astragals shall be formed of 2 inch x 12 ga offset steel strips applied to the face edge of the door leaf and plug welded within 2 inches of each end and between on centers not exceeding 8-inches. Ground welds smooth. Do not employ astragals with caps designed to increase the door width. Astragals on fire rated doors shall meet NFPA 80.

Lip length on strikes of door pairs are specified to flush the lip with the door face; thus astragals are not to be slotted for strike lips.

Interior door pairs which are fire rated more than 90 minutes, which occur in designated smoke walls, and to high security storage rooms shall be supplied with astragals. Security astragals shall be applied on the corridor side. Supply all other interior door pairs without astragals.

Provide astragals on exterior face of all exterior door pairs except where removable mulls occur, and where two vertical rod exit devices are scheduled.

2.6.3 Moldings

Provide moldings around glass of interior and exterior doors and louvers of interior doors. Provide nonremovable moldings on outside of exterior doors and on corridor side of interior doors. Other moldings may be stationary or removable. Secure inside moldings to stationary moldings, or provide snap-on moldings.

2.7 INSULATION CORES

Provide insulating cores at all exterior doors and other specific doors noted in the door schedule, and provide an apparent U-factor of .48 in accordance with SDI/DOOR 113 and conforming to:

- a. Rigid Polystyrene Foam Board: ASTM C578, Type I or II; or
- b. Mineral board: ASTM C612, Type I at fire rated doors.

2.8 STANDARD STEEL FRAMES

SDI/DOOR A250.8, Level 1, except as otherwise specified. Form frames to

sizes and shapes indicated, with welded corners. Provide steel frames for doors, cased openings, and interior glazed panels, unless otherwise indicated. Typical interior frames of 16 ga metal; 14 ga on frames for door over 48 inches wide or where heavyweight (HW) is scheduled. Provide frame product that uses a minimum of 25 percent recycled content. Provide data indicating percentage of recycled content for steel frame product.

2.8.1 Stainless Steel Frames

Material: ASTM A666, #304 alloy, #4 finish; minimum 16 ga. Factory prep for hardware; All hinge and lock reinforcing of 3/16 inch predrilled and tapped, backed by 12 ga stainless steel perimeter channels.

2.8.2 Design and Construction:

Custom made welded units. Profile and widths as detailed. Finished work shall be strong and true, free of defect, warp or buckle. Trim return not less than 1/2 inch.

At dry-wall construction, return backbend toward the inside of the frame as protection for the dry-wall face.

Where jambs die on a ramp or sill, which slopes more than 1/8 inch in width of frame, cut bottom of frame parallel with slope.

2.8.3 Welded Frames

Continuously weld frame faces at corner joints. Mechanically interlock or continuously weld stops and rabbets. Grind welds smooth.

Weld frames in accordance with the recommended practice of the Structural Welding Code Sections 1 through 6, AWS D1.1/D1.1M and in accordance with the practice specified by the producer of the metal being welded.

2.8.4 Mullions and Transom Bars

Provide mullions and transom bars of closed or tubular construction with heads and jambs butt-welded together. Bottom of door mullions must have adjustable floor anchors and spreader connections.

2.8.5 Stops and Beads

Provide form and loose stops and beads from 20 gage steel. Provide for glazed and other openings in standard steel frames. Secure beads to frames with oval-head, countersunk Phillips self-tapping sheet metal screws or concealed clips and fasteners. Space fasteners approximately 12 to 16 inch on center. Miter molded shapes at corners. Butt or miter square or rectangular beads at corners.

2.8.6 Cased Openings

Fabricate frames for cased openings of same material, gage, and assembly as specified for metal door frames, except omit door stops and preparation for hardware.

2.8.7 Anchors

Provide anchors to secure the frame to adjoining construction. Provide steel anchors, zinc-coated not lighter than 18 gage.

2.8.7.1 Wall Anchors

Provide at least three anchors for each jamb. For frames which are more than 7.5 feet in height, provide one additional anchor for each jamb for each additional 2.5 feet or fraction thereof.

- a. Masonry: Provide anchors of perforated steel straps or 3/16 inch diameter steel wire, adjustable or T-shaped;
- b. Stud partitions: Weld or otherwise securely fasten 18 ga. Z-clip anchors to backs of frames. Design anchors to be fastened to closed steel studs with sheet metal screws, and to open steel studs by wiring or welding;
- c. Completed openings: Secure frames to previously placed concrete or masonry with expansion bolts in accordance with SDI/DOOR 111; and

2.8.7.2 Floor Anchors

At each outside leg provide a custom, non-slotted anchor clip, one-piece 2 inch x 2 inch x 16 ga with length 1 inch less than frame width (full width of stop face on frames over 9 inches wide). Weld clips to the frame throat, and the horizontal leg (not pre-drilled) shall receive two anchor studs into the floor.

Seat interior mulls onto a nesting 12 ga steel bracket with upturned legs which is securely anchored to the floor slab. Place sidelight sills astride a 14 ga channel previously ram-set to floor, with outer faces of sill screwed to up-turned legs of channel. At exterior mulls provide two 12 ga angles welded inside tube and projected 2 inches below finish slab for grouting or casting in place.

At depressed slabs furnish appropriate extension clips

2.9 FIRE DOORS AND FRAMES

Provide fire doors and frames in accordance with NFPA 80 and this specification. Include insulated core materials in fire doors where indicated in the door schedule.

2.9.1 Labels

Provide fire doors and frames bearing the label of Underwriters Laboratories (UL), Factory Mutual Engineering and Research (FM), or Warnock Hersey International (WHI) attesting to the rating required. Testing must be in accordance with NFPA 252 or UL 10C. Provide labels that are metal with raised letters, bearing the name or file number of the door and frame manufacturer. Labels must be permanently affixed at the factory to frames and to the hinge edge of the door. Do not paint door and labels.

2.9.2 Oversized Doors

For fire doors and frames which exceed the size for which testing and labeling are available, furnish certificates stating that the doors and frames are identical in design, materials, and construction to a door which has been tested and meets the requirements for the class indicated.

2.9.3 Astragal on Fire Doors

On pairs of labeled fire doors, conform to NFPA 80 and UL requirements.

2.10 EXTERIOR FRAMES

Provide thermal insulation in all exterior frames. Provide frames of a minimum Level 4, with frames of a minimum thickness of 0.067 inch, 14 gage.

2.11 HARDWARE PREPARATION

Drill and tap doors and frames to receive finish hardware. Prepare doors and frames for hardware in accordance with the applicable requirements of SDI/DOOR A250.8 and SDI/DOOR A250.6. For additional requirements refer to ANSI/BHMA A156.115. Drill and tap for surface-applied hardware at the project site. Build additional reinforcing for surface-applied hardware into the door at the factory. Punch door frames, with the exception of frames that will have weatherstripping to receive a minimum of two rubber or vinyl door silencers on lock side of single doors and one silencer for each leaf at heads of double doors. Set lock strikes out to provide clearance for silencers.

2.12 FINISHES

2.12.1 Hot-Dip Zinc-Coated and Factory-Primed Finish

Fabricate standard steel doors and frames from hot dipped zinc coated steel, alloyed type, that complies with ASTM A924/A924M and ASTM A653/A653M. The coating weight must meet or exceed the minimum requirements for coatings having 0.4 ounces per square foot, total both sides, i.e., A40. Repair damaged zinc-coated surfaces by the application of zinc dust paint. Thoroughly clean and chemically treat to insure maximum paint adhesion. Factory prime as specified in SDI/DOOR A250.8..

2.12.2 Electrolytic Zinc-Coated Anchors and Accessories

Provide electrolytically deposited zinc-coated steel in accordance with ASTM A879/A879M, Commercial Quality, Coating Class A. Phosphate treat and factory prime zinc-coated surfaces as specified in SDI/DOOR A250.8.

2.13 FABRICATION AND WORKMANSHIP

Provide finished doors and frames that are strong and rigid, neat in appearance, and free from defects, waves, scratches, cuts, dents, ridges, holes, warp, and buckle. Provide molded members that are clean cut, straight, and true, with joints coped or mitered, well formed, and in true alignment. Dress exposed welded and soldered joints smooth. Design door frame sections for use with the wall construction indicated. Corner joints must be well formed and in true alignment. Conceal fastenings where practicable. Design frames in exposed masonry walls or partitions to allow sufficient space between the inside back of trim and masonry to receive caulking compound.

2.14 PROVISIONS FOR GLAZING

Materials are specified in Section 08 81 00, GLAZING.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Frames

Set frames in accordance with [SDI/DOOR A250.11](#). Plumb, align, and brace securely until permanent anchors are set. Anchor bottoms of frames with expansion bolts or powder-actuated fasteners. Build in or secure wall anchors to adjoining construction.

3.1.2 Doors

Hang doors in accordance with clearances specified in [SDI/DOOR A250.8](#). After erection and glazing, clean and adjust hardware.

3.1.3 Fire Doors and Frames

Install fire doors and frames, including hardware, in accordance with [NFPA 80](#). Install fire rated smoke doors and frames in accordance with [NFPA 80](#).

3.2 PROTECTION

Protect doors and frames from damage. Repair damaged doors and frames prior to completion and acceptance of the project or replace with new, as directed. Wire brush rusted frames until rust is removed. Clean thoroughly. Apply an all-over coat of rust-inhibitive paint of the same type used for shop coat.

3.3 CLEANING

Upon completion, clean exposed surfaces of doors and frames thoroughly. Remove mastic smears and other unsightly marks.

-- End of Section --

SECTION 08 14 00

WOOD DOORS

08/16, CHG 1: 08/18

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 80 (2022) Standard for Fire Doors and Other
Opening Protectives

WINDOW AND DOOR MANUFACTURERS ASSOCIATION (WDMA)

ANSI/WDMA I.S.1A (2013) Interior Architectural Wood Flush
Doors

ANSI/WDMA I.S.6A (2013) Interior Architectural Stile and
Rail Doors

WOODWORK INSTITUTE (WI)

NAAWS 3.1 (2017; 2018 Errata Edition) North American
Architectural Woodwork Standards

1.2 SUBMITTALS

Government approval is required for submittals. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Doors

Submit drawings or catalog data showing each type of door unit. Indicate within drawings and data the door types and construction, sizes, thickness, methods of assembly, and glazing.

SD-03 Product Data

Doors

Accessories

Water-resistant Sealer

Sample Warranty

SD-04 Samples

Doors

Prior to the delivery of wood doors, submit a sample section of each type of door which shows the stile, rail, veneer, finish, and core construction.

Door Finish Colors

Submit a minimum of three color selection samples , minimum 3 by 5 inches in size representing wood stain.

SD-06 Test Reports

Cycle-Slam

Hinge Loading Resistance

Submit cycle-slam test report for doors tested in accordance with ANSI/WDMA I.S.1A, and hinge loading resistance test report for doors tested in accordance with ANSI/WDMA I.S.6A.

SD-11 Closeout Submittals

Warranty

1.3 DELIVERY, STORAGE, AND HANDLING

Deliver doors to the site in an undamaged condition and protect against damage and dampness. Stack doors flat under cover. Support on blocking, a minimum of 4 inch thick, located at each end and at the midpoint of the door. Store doors in a well-ventilated building so that they will not be exposed to excessive moisture, heat, dryness, direct sunlight, or extreme changes of temperature and humidity. Do not store in a building under construction until concrete, masonry work, and plaster are dry. Replace defective or damaged doors with new ones.

1.4 WARRANTY

Warrant doors free of defects as set forth in the door manufacturer's standard door warranty.

PART 2 PRODUCTS

2.1 DOORS

Provide doors of the types, sizes, and designs free of urea-formaldehyde resins.

2.1.1 Stile and Rail Doors

Provide glazed stile and rail doors of solid, clear, air and kiln dried white oak, with 6 inch solid stiles and 12 inch bottom rails mortise and tenon waterproof glued joints. Provide muntin as shown on drawings.

Factory glaze with tempered glass meeting CPSC Standard 16-CFR. Outside glass back-puttied. Exterior doors wp glued. Stiles shall be of sufficient width to accept mortise locks.

2.1.2 Flush Doors

Conform to ANSI/WDMA I.S.1A for flush doors. Provide solid core doors; 5

ply Type I waterproof glued, with particleboard core. Sizes as scheduled. Cross-banding 1/16 inch before sanding. Double rail and stile edge bands at least 1-3/8 inch thick overall. Outer stile bands of hardwood matching face veneer and with no finger joints.

Face veneers of Premium Grade plain-sliced white oak. Color and grain characteristics shall be attractive and consistent throughout. Faces of pairs and batteries shall be reasonably matched. Pin knots, streaks, and similar defects shall occur only on room face of electric closets, mechanical rooms, janitor closets, etc. Veneer patches will not be allowed.

2.2 ACCESSORIES

2.2.1 Door Light Openings

Provide glazed openings with the manufacturer's standard wood moldings. Provide moldings for doors to receive natural finish of the same wood species and color as the wood face veneers. Typical stops shall be beveled, rebated, non-lip type of hardwood matching door veneer, set loose on one face. Seal stops and opening edges at shop.

2.2.2 Additional Hardware Reinforcement

Provide the minimum lock blocks to secure the specified hardware. The measurement of top, bottom, and intermediate rail blocks are a minimum 125 mm 5 inch by full core width. Comply with the manufacturer's labeling requirements for reinforcement blocking, but not mineral material similar to the core.

2.3 FABRICATION

2.3.1 Marking

Stamp each door with a brand, stamp, or other identifying mark indicating quality and construction of the door.

2.3.2 Quality and Construction

Identify the standard on which the construction of the door was based and identify doors having a Type I glue bond.

2.3.3 Preservative Treatment

Treat doors scheduled for restrooms, janitor closets and other possible wet locations including exterior doors with a water-repellent preservative treatment and so marketed at the manufacturer's plant.

2.3.4 Adhesives and Bonds

ANSI/WDMA I.S.1A. Use Type I bond for exterior doors and Type II bond for interior doors. Provide a nonstaining adhesive on doors with a natural finish.

2.3.5 Finishes

2.3.5.1 Field Painting

Factory prime or seal doors, and field paint.

2.3.5.2 Factory Stained Finish

Provide doors finished at the factory by the door manufacturer as follows:

WDMA System TR-8 (UV cured acrylated polyester/urethane) or TR-2 (catalyzed lacquer) or TR-4 (conversion varnish) factory finish systems that utilize water-based stains and finishes with ultraviolet UV protection. The coating is NAAWS 3.1 premium, medium rubbed sheen, closed grain effect. Use stain when required to produce the finish specified for color. Seal edges, cutouts, trim, and wood accessories, and apply two coats of finish compatible with the door face finish. Touch-up finishes that are scratched or marred, or where exposed fastener holes are filled, in accordance with the door manufacturer's instructions. Match color and sheen of factory finish using materials compatible for field application.

2.3.5.3 Color

Provide door finish colors

2.3.6 Water-Resistant Sealer

Provide manufacturer's standard water-resistant sealer compatible with the specified finishes.

2.4 SOURCE QUALITY CONTROL

Meet or exceed the following minimum performance criteria of styles of "B" and "C" label fire doors utilizing standard mortise leaf hinges:

- a. Cycle-slam: Heavy Duty Doors: 500,000 cycles with no loose hinge screws or other visible signs of failure when tested in accordance with the requirements of ANSI/WDMA I.S.1A.
- b. Hinge loading resistance: Averages of ten test samples not less than Heavy Duty doors: 475 pounds force when tested for direct screw withdrawal in accordance with ANSI/WDMA I.S.6A using a No. 12, 1-1/4 inch long, steel, fully threaded wood screw. Drill 5/32 inch pilot hole, use 1-1/2 inch opening around screw for bearing surface, and engage screw full, except for last 1/8 inch. Do not use a steel plate to reinforce screw area.

PART 3 EXECUTION

3.1 INSTALLATION

Do not install building construction materials that show visual evidence of biological growth.

Before installation, seal top and bottom edges of doors with the approved water-resistant sealer. Seal cuts made on the job immediately after cutting using approved water-resistant sealer. Fit, trim, and hang doors with a 1/16 inch minimum, 1/8 inch maximum clearance at sides and top, and a 3/16 inch minimum, 1/4 inch maximum clearance over thresholds. Provide 3/8 inch minimum, 7/16 inch maximum clearance at bottom where no threshold occurs. Bevel edges of doors at the rate of 1/8 inch in 2 inch. Door warp must not exceed 1/4 inch when measured in accordance with ANSI/WDMA I.S.1A.

3.1.1 Fire Doors

Install fire doors in accordance with NFPA 80. Do not paint over labels.

-- End of Section --

SECTION 08 31 00

ACCESS DOORS AND PANELS

05/17, CHG 1: 08/18

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M (2020; Errata 1 2021) Structural Welding
Code - Steel

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M (2019) Standard Specification for Carbon
Structural Steel

ASTM A653/A653M (2022) Standard Specification for Steel
Sheet, Zinc-Coated (Galvanized) or
Zinc-Iron Alloy-Coated (Galvannealed) by
the Hot-Dip Process

ASTM A1008/A1008M (2021a) Standard Specification for Steel,
Sheet, Cold-Rolled, Carbon, Structural,
High-Strength Low-Alloy, High-Strength
Low-Alloy with Improved Formability,
Solution Hardened, and Bake Hardenable

ASTM E119 (2022) Standard Test Methods for Fire
Tests of Building Construction and
Materials

MASTER PAINTERS INSTITUTE (MPI)

MPI 79 (2016) Primer, Alkyd, Anti-Corrosive for
Metal

UNDERWRITERS LABORATORIES (UL)

UL 10B (2008; Reprint May 2020) Fire Tests of
Door Assemblies

UL 263 (2011; Reprint Aug 2021) UL Standard for
Safety Fire Tests of Building Construction
and Materials

1.2 SUBMITTALS

Government approval is required for submittals. Submit the following in accordance with Section **01 33 00** SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Access Doors And Panels

SD-03 Product Data

Access Doors And Panels

Hardware Including Locks and Keys

Accessories

Recycled Content

SD-04 Samples

Finishes

1.3 MISCELLANEOUS REQUIREMENTS

For access doors and panels provide the following:

1.3.1 Shop Drawings

For field assembled access doors and panels, provide plans, elevations, sections, and details for each type of access door and panel assembly. Indicate frame, surface and edge construction, materials, and accessories. Indicate types of finished surfaces and details for panel edge conditions. Provide a door schedule with a unique number for each access door and panel, specific location in the project, location of hinges and hardware for each door.

1.3.2 Product Data

For shop assembled access doors and panels, provide literature indicating sizes, types, frame and edge construction, finishes, hardware, accessories such as gaskets, seals and weatherstripping, and location of each door and panel in the project. Indicate. Provide details of adjoining work for each condition indicated.

1.3.3 Finish Samples

Submit two color charts from manufacturer's standard color and finish options for each type of frame and panel assembly finish indicated.

1.4 PERFORMANCE REQUIREMENTS

1.4.1 Insulated Access Panels

Provide panels in a thickness as necessary to achieve a minimum R-value of 5.0. Provide gasketing as necessary for an airtight installation.

1.4.2 Access Panels for Wet Areas

Provide panel assemblies that will be located in wet areas with corrosion resistant finishes and hardware and water resistant gasketing.

1.5 DELIVERY, STORAGE, AND PROTECTION

Protect from corrosion, deformation, and other types of damage. Store

items in an enclosed area free from contact with soil and weather. Remove and replace damaged items with new items.

PART 2 PRODUCTS

2.1 RECYCLED CONTENT

Provide products with recycled content. Provide data for each product with recycled content, identifying percentage of recycled content.

2.2 MATERIALS

2.2.1 Steel Plates, Shapes, and Bars

Provide in accordance with [ASTM A36/A36M](#).

2.2.2 Sheet Steel

Provide cold rolled steel sheet substrate in accordance with [ASTM A1008/A1008M](#), Commercial Steel (CS), exposed.

2.2.3 Metallic Coated Steel Sheet

Provide in accordance with [ASTM A653/A653M](#), Commercial Steel (CS), Type B; with minimum G60 (Z180) or A60 (ZF180) metallic coating.

2.2.4 Hardware

Provide automatic closing devices. Provide latch releases operable from insides of doors. Provide anchors in accordance with applicable fire test parameters.

2.2.5 Hinges

Provide concealed spring hinges, 175 degrees of opening, with non-removable hinge pins. Provide hinges of same steel as door and frame or in accordance with manufacturer's written recommendations. Provide coatings as necessary to permanently protect dissimilar metals from contact with one another; see Part 3 herein for more information.

2.2.6 Locks

Unless otherwise indicated, provide flush screwdriver operated cam lock. Provide plastic sleeve or stainless steel bushings to protect holes in surface finishes for screwdriver to access lock.

2.2.7 Accessories

Provide anchors in size, number and location on four sides to secure access door to substrate. Provide anchors in types as recommended by manufacturer's written installation instructions for each substrate indicated. Provide shims, bushings, clips, gaskets, and other devices as necessary for a complete installation.

2.3 FABRICATION

2.3.1 Thickness, Size, Edges

Fabricate frames for access doors of steel not lighter than [26](#) gage with

welded joints and with a drywall bead flange. Provide doors a minimum of 24 by 36 inches and of not lighter than 20 gage steel, with stiffened edges and welded attachments. Provide with eased (lightly rounded) edges, without burrs, snags or sharpness and exposed welds ground smooth.

2.3.2 Welding

Provide in accordance with AWS D1.1/D1.1M.

2.4 ACCESS ASSEMBLY TYPES

Unless indicated otherwise, provide flush-face steel access doors and panels with steel frames and flanges.

2.4.1 Fire-rated Doors

2.4.1.1 Door Construction

Provide ceiling access door construction in accordance with ASTM E119 or UL 263.

2.4.1.2 Labels

Provide class B opening according to UL 10B or test by another nationally recognized laboratory, approved by the Contracting Officer. Provide fire-rating as indicated herein, with a maximum temperature rise of 216 degrees F.

2.4.1.3 Door Panel and Frame

Steel sheet, with mineral fiber insulation core, insulated sandwich type construction.

2.4.2 Insulated Doors

Provide access door panels with 25 pounds per square inch density polystyrene with a flame spread rating of no more than 25.

Provide ceiling access panels for access to attic and roof equipment as indicated.

2.5 FINISHES

Provide steel frames and panel surfaces with a powder coated finish. Provide manufacturer's standard two coat finish system consisting of one coat primer and one thermoset topcoat. Provide dry film thickness in 2 mils minimum. Provide exposed fastenings that approximately match the color and finish of the each material to which fastenings are applied.

PART 3 EXECUTION

3.1 PREPARATION

Field verify all measurements prior to fabrication. Verify access door locations and sizes provide required maintenance access to installed building services components. Protect existing construction and completed work from damage during installation.

3.2 GENERAL INSTALLATION REQUIREMENTS

Install items at locations indicated, in accordance with manufacturer's written instructions. Include materials and parts as necessary for a complete installation of each item. Conceal fastenings where practicable. Poor matching of holes to fasteners is cause for rejection of the work.

3.3 ACCESS LOCATIONS

Install removable access panels directly below each valve, flow indicator, damper, air splitter or other utility requiring access that is located above ceilings, other than at acoustical panel ceilings, and that would otherwise not be accessible. Install access doors and panels permitting access to service valves, traps, dampers, cleanouts, and other mechanical, electrical and conveyor control items concealed in walls and partitions.

3.4 ACCESS LOCATIONS IN WET AREAS

When possible, avoid locating access panels in wet areas. When such locations cannot be avoided, provide moisture resistant assemblies as indicated in Part I herein.

3.5 FIELD PAINTING

Field painting primed access doors in accordance with the requirements of Section 09 90 00 PAINTS AND COATINGS.

3.6 DISSIMILAR MATERIALS

Where dissimilar metals are in contact, protect surfaces with a coating in accordance with MPI 79 to prevent galvanic or corrosive action.

3.7 ADJUSTMENT

Adjust hardware so that door panel opens freely. Adjust door when closed center door panel in frame.

3.8 ENVIRONMENTAL CONDITIONS

Do not paint surfaces when damp or exposed to weather, when surface temperature is below 45 degrees F or over 95 degrees F, unless approved by the Contracting Officer.

-- End of Section --

SECTION 08 41 13

ALUMINUM-FRAMED ENTRANCES AND STOREFRONTS

08/18, CHG 1: 08/18

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION (AAMA)

AAMA 501	(2015) Methods of Test for Exterior Walls
AAMA 1503	(2009) Voluntary Test Method for Thermal Transmittance and Condensation Resistance of Windows, Doors and Glazed Wall Sections
AAMA 2605	(2020) Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7-16	(2017; Errata 2018; Supp 1 2018) Minimum Design Loads and Associated Criteria for Buildings and Other Structures

ASTM INTERNATIONAL (ASTM)

ASTM B221	(2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM E283	(2019) Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen
ASTM E330/E330M	(2014; R 2021) Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference
ASTM E331	(2000; R 2016) Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference
ASTM E783	(2002; R 2018) Standard Test Method for Field Measurement of Air Leakage Through Installed Exterior Windows and Doors

- ASTM E1105** (2015) Standard Test Method for Field Determination of Water Penetration of Installed Exterior Windows, Skylights, Doors, and Curtain Walls, by Uniform or Cyclic Static Air Pressure Difference
- ASTM E1424** (2022) Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure and Temperature Differences Across the Specimen
- ASTM E1996** (2017) Standard Specification for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Windborne Debris in Hurricanes
- ASTM F1642/F1642M** (2017) Standard Test Method for Glazing and Glazing Systems Subject to Airblast Loadings

BUILDERS HARDWARE MANUFACTURERS ASSOCIATION (BHMA)

- ANSI/BHMA A156.10** (2017) Power Operated Pedestrian Doors

GLASS ASSOCIATION OF NORTH AMERICA (GANA)

- GANA Glazing Manual** (2008) Glazing Manual

INTERNATIONAL CODE COUNCIL (ICC)

- ICC IBC** (2021) International Building Code

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

- FS TT-P-645** (Rev C; Notice 1) Primer, Paint, Zinc-Molybdate, Alkyd Type

UNDERWRITERS LABORATORIES (UL)

- UL 325** (2017; Reprint Feb 2020) UL Standard for Safety Door, Drapery, Gate, Louver, and Window Operators and Systems

1.2 ADMINISTRATIVE REQUIREMENTS

1.2.1 Pre-Installation Meetings

Conduct a meeting before installation begins to verify the project requirements, substrate conditions, manufacturer's installation instructions, and manufacturer's warranty requirements.

Within 30 days of the Contract Award, submit the following for review and approval by the Contracting Officer:

- a. **List of product installations**

- b. Sample warranty
- c. Finish and color samples
- d. Manufacturer's catalog data

Concurrently submit **certified test reports** showing compliance with specified performance characteristics and **UL 325** for the following:

- a. Wind Load (Resistance) in accordance with **AAMA 501**
- b. Deflection in accordance with **ASTM F1642/F1642M**
- c. Condensation Resistance and Thermal Transmittance Performance Requirements in accordance with **AAMA 1503**
- d. Water Infiltration in accordance with **ASTM E331**
- e. Structural Requirements in accordance with **ASTM F1642/F1642M**

1.3 SUBMITTALS

Government approval is required for submittals . Submit the following in accordance with Section **01 33 00** SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Sample Warranty

List of Product Installations

SD-02 Shop Drawings

Installation Drawings

Fabrication Drawings

SD-03 Product Data

Manufacturer's Catalog Data

Finish

Recycled Content of Aluminum Material

SD-04 Samples

Finish and Color Samples

SD-06 Test Reports

Certified Test Reports

Deflection

Air Infiltration

Condensation Resistance and Thermal Transmittance

Water Infiltration

SD-08 Manufacturer's Instructions

Manufacturer's Instructions

SD-11 Closeout Submittals

Manufacturer's Product Warranty

1.4 QUALITY CONTROL

1.4.1 Qualifications

1.4.1.1 Installer Qualifications

Provide documentation of the installer's experience in performing the work specified in this section.

Ensure that the installers are specialized in work similar to that required for this project, and that they are acceptable to product manufacturer.

1.4.1.2 Manufacturer Qualifications

Ensure that manufacturers meet the requirements specified in this section and project drawings.

Ensure that the manufacturer is capable of providing field service representation during construction, approving acceptable installers and approving application methods.

1.4.2 Single-Source Responsibility

When aluminum entrances are part of a building enclosure system, that includes storefront framing, windows, a curtain wall system, and related products, provide building enclosure system products from a single-source manufacturer.

Use a single source manufacturer with sole responsibility for providing design, structural engineering, and custom fabrication for door portal systems and for supplying components, materials, and products. Do not use products provided from numerous sources for assembly at the site. Ensure that the following work items and components are fabricated or supplied by a single source are:

- a. Glass as specified in Section 08 81 00 GLAZING

1.5 DELIVERY, STORAGE, AND HANDLING

1.5.1 Ordering

To avoid construction delays, comply with the manufacturer's lead-time requirements and instructions for ordering.

1.5.2 Packing, Shipping, Handling and Unloading

Deliver materials in the manufacturer's original, unopened, undamaged containers with identification labels intact.

1.5.3 Storage and Protection

Store materials in a way that protects them from exposure to harmful weather conditions. Avoid damaging the storefront material and components during handling. Protect storefront material against damage from elements, construction activities, and other hazards before, during, and after storefront installation.

Do not use adhesive papers or sprayed coatings that become firmly bonded when exposed to sunlight. Do not leave coating residue on surfaces.

1.6 PROJECT / SITE CONDITIONS

1.6.1 Field Measurements

Verify actual measurements or openings by taking field measurements before fabrication; record these measurements on shop drawings. To avoid construction delays, coordinate field measurements, and fabrication schedule with construction progress.

1.7 WARRANTY

Provide a written manufacturer's warranty, executed by a company official, warranting against defects in materials and products for 2 years from the date of shipment. Warrant that the door corner construction is for the life of the project. Provide a written installer's warranty, warranting work to be watertight and free from defective materials, defective workmanship, and glass breakage as a result of defective design, and agreeing to replace components that fail within 2 years.

The warranty states the following:

- a. Watertight and airtight system installation is completed within specified tolerances.
- b. The completed installation remains free of rattles, wind whistles and noise caused by thermal movement and wind pressure.
- c. System is structurally sound and free from distortion.
- d. Glass and glazing gaskets will not break or "pop" from frames as a result of design, wind load pressure, movement caused by expansion or contraction, or structural loading.
- e. Glazing sealants and gaskets remain free of abnormal deterioration or dislocation as a result of sunlight, weather, or oxidation.

Provide written warranty stating that the organic coating finish will not fade more than 10 percent or show chalking, yellowing, peeling, cracking, pitting, corroding or variations in color, or gloss deterioration beyond the manufacturer's descriptive standards for 15 years from the shipment date and agreeing to promptly correct defects.

Provide a written thermal integrity warranty for 10 years from ship date against thermal barrier system failure resulting from the following:

- a. Longitudinal and transverse thermal barrier shrinkage.

- b. Thermal barrier cracking.
- c. Structural failure of the thermal barrier material.
- d. Loss of adhesion or loss of prescribed edge pressure on glazing material, resulting in excessive air and water infiltration.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

Provide aluminum entrances, with glass and glazing, door hardware, and components.

Aluminum entrances include impact resistance entrances; medium stile, 3 1/2 inch vertical face dimension, 1 3/4 inch depth, for interior structural silicone glaze, for high-traffic/impact-resistant applications.:

2.1.1 Design Requirements for Aluminum (Entrances and Components)

Provide a door portal system designed to withstand the following loads without breakage, loss, failure of seals, product deterioration, or other defects.

- a. Dead and Live Loads: Determined by ASCE 7-16 and calculated in accordance with applicable codes.
- b. Seismic Loads: Design and install the system to comply with the seismic requirements for the project location in accordance with Section 1613 of the International Building Code, ICC IBC.
- c. Wind Loads: Design and install the system so that the effects of wind load acting inward and outward normal to the plane of the wall are in accordance with ASTM E330/E330M.
- d. Thermal Loads And Movement:
 - (1) Ambient Temperature Range: 120 degrees F
 - (2) Material Surfaces Range: 180 degrees F
- e. Water and Air Resistance: Provide weatherstripping, exterior gaskets, sealants, and other accessories to resist water and air penetration.
- f. Impact-Protective Systems Provide an impact-protective system in accordance with ASTM E1996.

2.1.1.1 Material Standard

ASTM B221; 6063-T5 alloy and tempered.

Provide door stile and rail face dimensions of the entrance doors as follows:

Vertical Stile	Top Rail	Bottom Rail
3-1/2 inches	3-1/2 inches	10 inches

Provide major portions of the door members at 0.125 inches nominal in

thickness and glazing molding at 0.050 inches thick.

2.1.1.2 Recycled Content

Provide aluminum framed entrances and storefronts that have a minimum of 20 percent recycled content based upon the aluminum billet used in the original material. Provide data indicating percentage of recycled content of aluminum material.

2.1.1.3 Sealants

Provide either ethylene propylene diene monomer (EPDM) elastomeric extrusions or thermoplastic elastomer glazing gaskets. Structural silicone sealant is required.

Internal Sealants: Provide sealants that according to the manufacturer will remain permanently elastic, tacky, non-drying, non-migrating, and weather tight.

2.1.1.4 Thermal Barrier

Use a rigid, structural thermal barrier to separate all exterior aluminum from interior aluminum. For purposes of this specification, a structural thermal barrier is defined as a system that transfers shear during bending and, therefore, promotes composite action between the exterior and interior extrusions. Do not use a nonstructural thermal barrier. Ensure that the thermal barrier provides a structural connection between the two sides of the door.

2.2 FABRICATION

Provide the following information when submitting fabrication drawings for custom fabrications:

- a. Indicate elevations, detailed design, dimensions, member profiles, joint locations, arrangement of units, and member connections.
- b. Show the following items:
 - (1) Details of special shapes.
 - (2) Reinforcing.
 - (3) Anchorage system.
 - (4) Interfacing with building construction.
 - (5) Provisions for expansion and contraction.
 - (6) Thermal breaks.
- c. Indicate typical glazing details, and internal sealant requirements as recommended by the sealant manufacturer.
- d. Clearly indicate locations of exposed fasteners and joints.
- e. Clearly show where and how the manufacturer's system deviates from Contract drawings and these specifications.

2.2.1 Entrance System Fabrication

Provide door corner construction consisting of mechanical clip fastening, SIGMA deep penetration plug welds and 1 1/8 inch long fillet welds inside and outside all four corners. Provide a hook-in type exterior glazing stop with EPDM glazing gaskets reinforced with non-stretchable cord. Provide an interior glazing stop that is mechanically fastened to the door member and that incorporates a silicone-compatible spacer used with silicone sealant.

Accurately fit and secure joints and corners. Make joints hairline in appearance. Remove burrs and smooth edges. Prepare components with internal reinforcement for door hardware. Arrange fasteners and attachments so that they are concealed from view.

Provide muntin grids applied to the exterior of the Door lites and adjacent sidelights and transoms as shown on the details. Muntin grids shall match the size and profile of the muntin grids applied to the aluminum fixed windows and shall be applied at the exterior glass surface only. Permanently pin grids or otherwise fasten with mechanical fasteners to a perimeter beveled muntin base which shall in turn be glazed into the glass pocket with the insulated glass. TAPE OR SILICONE APPLICATION, OR MUNTINS "CLIPPED" ON TO THE EXTERIOR FACE OF THE FRAME AND NOT PERMANENTLY SECURED ARE NOT ACCEPTABLE FOR USE ON THIS PROJECT.

Separate dissimilar metals with protective coating or pre-formed separators to prevent contact and corrosion.

2.2.2 Shop Assembly

Fabricate and assemble units with joints only at the intersection of aluminum members with hairline joints; rigidly secure these units, and seal them in accordance with the manufacturer's recommendations.

2.2.2.1 Welding

Conceal welds on aluminum members in accordance with AWS recommendations or methods recommended by the manufacturer. Members showing welding bloom or discoloration on finish or material distortion will be rejected by the Contacting Officer.

2.2.3 Finish

2.2.3.1 High Performance Organic Coating

Provide manufacturer's standard 2 coat Fluoropolymer 70 percent Kynar baked on, electrostatically applied coating, over aluminum extrusions and panels; meeting requirements of AAMA 2605; color as selected by the Architect from the manufacturer's standard range.

Provide touch-Up Materials as recommended by coating manufacturer for field application.

2.2.4 Fabrication Tolerance

Fabricate and assemble units with joints only at intersection of aluminum members with hairline joints; rigidly secure these units, and seal them in accordance with the manufacturer's recommendations.

Fabricate aluminum entrances in accordance with the entrance manufacturer's prescribed tolerances.

2.2.4.1 Material Cuts

Square to $\frac{1}{32}$ inch off square, over largest dimension; proportionate amount of $\frac{1}{32}$ inch on the two dimensions.

2.2.4.2 Maximum Offset at Consecutive Members

$\frac{1}{64}$ inch in alignment between two consecutive members in line, end to end.

2.2.4.3 Maximum Offset at Glazing Pocket Corners

$\frac{1}{64}$ inch between framing members at glazing pocket corners.

2.2.4.4 Joints

Between adjacent members in same assembly: Joints are hairline and square to the adjacent member.

2.2.4.5 Variation

In squaring diagonals for doors and fabricated assemblies: $\frac{1}{16}$ inch.

2.2.4.6 Flatness

For doors and fabricated assemblies: plus/minus $\frac{1}{16}$ inch of neutral plane.

2.3 MATERIALS

2.3.1 Sealants

Refer to Section 07 92 00 JOINT SEALANTS. Provide suitable type in accordance with applicable portions of GANA Glazing Manual. Setting materials shall match the window finish, be non-staining, and not require painting. Other materials that will be exposed to view and unpainted shall be black, white or neutral color as specified by the Architect. Provide structural silicone glazing compound with a low modulus and blast tested.

2.3.2 Glass

The glass shall be pre-glazed by the window manufacturer. The glass shall conform to all requirements of ASTM C1036. Glass thickness shall meet or exceed the values given in ASTM E1300 for the design pressure rating of the project.

2.3.2.1 Insulating Glass Units

Specified insulated glazing units (IGUs) at exterior windows and storefront at exterior openings are to comply with UFC 4-010-01, Section 3-11.1 - Standard 10 - Glazing. IGU are to include in inner pane with $\frac{1}{4}$ inch nominal laminated glass consisting of two $\frac{1}{8}$ inch glass panes bonded together with a min. of 0.030 in. interlayer of material that has typically been used in blast resistant window applications. Polycarbonate panes are not acceptable. Refer to the bite requirements for the frames and sealing beads in UFC 4-010-01 Section 3-11.1 - Standard 10.

Refer to Section 08 81 00 GLAZING for additional requirements for Insulated Glass Units. .

2.4 ACCESSORIES

2.4.1 Fasteners

Provide stainless steel fasteners in areas where the fasteners are exposed.

Use non-corrosive and compatible fasteners with components being fastened. Do not use exposed fasteners, except where unavoidable for application of hardware.

In areas where fasteners are not exposed, use aluminum, non-magnetic stainless steel, or other materials warranted by the manufacturer.

For exposed locations, provide countersunk Phillips head screws when items with a matching finish are fastened. For concealed locations, provide the manufacturer's standard fasteners.

Provide nuts or washers that have been designed with a means to prevent disengagement; do not deform fastener threads.

2.4.2 Perimeter Anchors

When steel anchors are used, provide insulation between steel material and aluminum material to prevent galvanic action.

2.4.2.1 Inserts and Anchorage Devices

Provide manufacturer's standard formed or fabricated assemblies, steel or aluminum, of shapes, plates, bars, or tubes. Shop-coat steel assemblies after fabrication with an alkyd zinc chromate primer complying with FS TT-P-645.

2.4.3 Glazing gaskets

Provide glazing gaskets made of EPDM. Gaskets shall be inserted into ready-made grooves in the aluminum sections.

Provide glazing accessories as required to supplement the accessories provided with the items to be glazed and to provide a complete installation, including glazing points, clips, shims, angles, beads, setting blocks, and spacer strips. No ferrous metal accessories, except for stainless steel, will be exposed in the finished work.

2.4.4 Standard Entrance Hardware

Refer to Section 08 71 00 for hardware requirements in addition to information listed below.

2.4.4.1 Weatherstripping

Equip meeting stiles on pairs of doors with an adjustable astragal using wool pile with a polymeric fin.

Provide door weatherstripping on a single-acting offset pivot or butt-hung door and frame (single or pairs) consisting of a thermoplastic elastomer weatherstripping on a tubular shape with a semi-rigid polymeric backing.

Provide sill-sweep strips: Provide an EPDM blade gasket sweep strip in an aluminum extrusion applied to the interior exposed surface of the bottom rail with concealed fasteners. (Provide as necessary to meet specified performance tests.)

2.4.4.2 Threshold

Provide an extruded aluminum threshold, one piece per door opening, with ribbed surface.

PART 3 EXECUTION

3.1 EXAMINATION

3.1.1 Site Verification of Conditions

Verify that the condition of substrate previously installed under other sections is acceptable for product installation in accordance with the manufacturer's instructions.

Verify that openings are sized to receive the storefront system and that the sill plate is level in accordance with the manufacturer's acceptable tolerances.

3.2 PREPARATION

Field-verify dimensions before fabricating components for the door portal assembly.

Coordinate requirements for locations of blockouts for anchorage of door portal columns and other embedded components with Section 03 30 00 CAST-IN-PLACE CONCRETE.

Coordinate the erection of door portal with installation of surrounding glass wall and door assemblies. Ensure that the door portals can provide support and anchorage for assembly components.

Coordinate electrical requirements for electrified door hardware to ensure proper power source, conduit, wiring, and boxes.

3.2.1 Adjacent Surfaces Protection

Protect adjacent work areas and finish surfaces from damage during product installation.

3.2.2 Aluminum Surface Protection

Protect aluminum surfaces from contact with lime, mortar, cement, acids, and other harmful contaminants.

3.3 INSTALLATION

Submit [installation drawings](#) for review and approval.

Install the entrance system in accordance with the [manufacturer's instructions](#) and the AAMA storefront and entrance guide specifications manual. Attach the entrance system to the structure, allowing it to be adjusted to accommodate construction tolerances and other irregularities.

Provide alignment attachments and shims to permanently fasten the system to the building structure. Align the assembly so that it is plumb and level, and free of warp and twist. Maintain assembly dimensional tolerances aligning with adjacent work.

Set thresholds in a bed of mastic and secure the thresholds. Protect aluminum members in contact with masonry, steel, concrete, or dissimilar materials using nylon pads or a bituminous coating. Shim and brace the aluminum system before anchoring the system to the structure. Verify that weep holes are open, and the metal joints are sealed in accordance with the manufacturer's installation instructions. Seal metal-to-metal joints using a sealant recommended by the system manufacturer.

3.3.1 Tolerances

Ensure that tolerances for wall thickness and other cross-sectional dimensions of entrance members are nominal and in compliance with Aluminum Standards and Data, published by the Aluminum Association.

3.3.2 Adjusting

Adjust operating hardware for smooth operation, and as recommended by the manufacturer.

3.3.3 Related Products Installation Requirements

3.3.3.1 Sealants (Perimeter)

Refer to Section 07 92 00 JOINT SEALANTS.

3.3.3.2 Glass

Refer to Section 08 81 00 GLAZING.

3.4 FIELD QUALITY CONTROL

3.4.1 Air Infiltration

Test air infiltration in accordance with ASTM E783

Submit certified test reports showing compliance with specified performance characteristics as follows:

- a. For single-acting offset pivot, butt hung, or continuous geared hinge entrances in the closed and locked position, test the specimen in accordance with ANSI/BHMA A156.10, and ASTM E283 at a pressure differential of 1.57 psf for pairs of doors; ensure that maximum infiltration for a pair of 7 foot by 8 foot entrance doors and frame is 1.2 cfm/square foot.
- b. Ensure the maximum allowable infiltration for a completed storefront system does not exceed 0.06 cfm/square foot when tested in accordance with ASTM E1424 at a differential static pressure of 6.24 psf.

3.4.2 Wind Loads

Design and size components to withstand the specified load requirements without damage or permanent set, when tested in accordance with ASTM E330/E330M, using loads 1.5 times the design wind loads and 10 second

duration of maximum load.

A. Design Wind Loads: Comply with requirements of ASCE 7.

3.4.3 Deflection

Submit certified test reports showing that the maximum allowable deflection in a member when tested in accordance with ASTM E330/E330M with allowable stress is $L/175$ or $3/4$ inches maximum.

3.4.4 Condensation Resistance and Thermal Transmittance

Submit certified test reports showing compliance with specified performance characteristics as follows:

a. U-Value Requirements:

- (1) Perform test in accordance with the AAMA 1503 procedure and on the configuration specified therein.
- (2) Thermal Transmittance ("U" Value) maximum 0.65 (6250) BTU/hr/sf/deg F at 15 mph exterior wind.

3.4.5 Water Infiltration

Submit certified test reports showing that the system is designed to provide no uncontrolled water when tested in accordance with ASTM E1105 at a static pressure of 8 psf.

3.5 ADJUSTING AND CLEANING

3.5.1 Protection

Protect the installed product's finish surfaces from damage during construction. Protect the aluminum storefront system from damage from grinding and polishing compounds, plaster, lime, acid, cement, or other harmful contaminants.

3.5.2 Cleaning

Repair or replace damaged installed products. Clean installed products in accordance with manufacturer's instructions before acceptance remove excess mastic, mastic smears, and other foreign materials. Remove construction debris from the project site and legally dispose of this debris.

3.6 WARRANTY

Submit three signed copies of the manufacturer's product warranty for the entrance system as follows:

- a. Warranty Period: Ten years from Date of Substantial Completion of the project, provided that the Limited Warranty begins no later than six months from the date of shipment by the manufacturer. In addition, support welded door corner construction with a limited lifetime warranty for the life of the door under normal use.

Ensure that the Warranty's language is identical to the "As Approved" version of the sample warranty submitted to and returned from the Contracting Officer.

-- End of Section --

SECTION 08 51 13

ALUMINUM WINDOWS

05/19

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION (AAMA)

AAMA 907	(2015) Voluntary Specification for Corrosion Resistant Coatings on Carbon Steel Components Used in Windows, Doors and Skylights
AAMA 1503	(2009) Voluntary Test Method for Thermal Transmittance and Condensation Resistance of Windows, Doors and Glazed Wall Sections
AAMA 2605	(2020) Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels
AAMA/WDMA/CSA 101/I.S.2/A440	(2017) North American Fenestration Standard/Specification for Windows, Doors, and Skylights

ASTM INTERNATIONAL (ASTM)

ASTM E330	(2002; R 2010) Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference
ASTM E90	(2009; R2016) Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements
ASTM E1300	(2016) Standard Practice for Determining Load Resistance of Glass in Buildings
ASTM F2248	(2012) Standard Practice for Specifying an Equivalent 3-Second Duration Design Loading for Blast Resistant Glazing Fabricated with Laminated Glass

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 4-010-01	(2018; with Change 2, 2022) DoD Minimum Antiterrorism Standards for Buildings

1.2 SUBMITTALS

Government approval is required for submittals. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Windows

Fabrication Drawings

SD-03 Product Data

Windows

Fasteners

Window Performance

Thermal-Barrier Windows

Mullions

Accessories

Adhesives

SD-04 Samples

Finish Sample

Window Sample

SD-05 Design Data

Structural Calculations for Deflection

SD-06 Test Reports

Minimum Condensation Resistance Factor

SD-10 Operation and Maintenance Data

Windows, Data Package 1

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

1.3 QUALITY ASSURANCE

1.3.1 Qualification of Manufacturer

Comply with applicable recommended specification(s) of recognized national or international industry standards for window materials. The window manufacturer will be participating members of the American Architectural Manufacturers Association (AAMA) and have certified products in their window certification program.

Window manufacturer must specialize in designing and manufacturing the

type of aluminum windows specified in this section, and have a minimum of 3 years of documented successful experience. Manufacturer must have the facilities capable of meeting contract requirements, single-source responsibility and warranty.

1.3.2 Shop Drawing Requirements

Take field measurements prior to preparation of drawings and fabrications. Provide drawings that indicate elevations of windows, full-size sections, thickness and gages of metal, fastenings, proposed method of anchoring, size and spacing of anchors, details of construction, method of glazing, details of operating hardware, mullion details, material and method of attaching subframes, sills, trim, installation details, and other related items.

1.3.3 Sample Requirements

1.3.3.1 Finish Sample Requirements

Submit color chart of standard factory color coatings when factory-finish color coating is to be provided.

1.3.3.2 Window Sample Requirements

Submit one full-size corner of each window type proposed for use.

1.3.4 Test Report Requirements

Submit test reports for each type of window attesting that identical windows have been tested and meet the requirements specified herein for conformance to AAMA/WDMA/CSA 101/I.S.2/A440 including test size, minimum condensation resistance factor (CRF).

1.3.5 Certification

Each prime window unit must bear the AAMA Label warranting that the product complies with AAMA/WDMA/CSA 101/I.S.2/A440. Certified test reports attesting that the prime window units meet the requirements of AAMA/WDMA/CSA 101/I.S.2/A440, including test size, will be acceptable in lieu of product labeling.

1.4 DELIVERY AND STORAGE

Deliver windows to project site in an undamaged condition. Use care in handling and hoisting windows during transportation and at the jobsite. Store windows and components out of contact with the ground, under a weathertight covering, so as to prevent bending, warping, or otherwise damaging the windows. Repair damaged windows to an "as new" condition as approved. If windows can not be repaired, provide a new unit.

1.5 WINDOW PERFORMANCE REQUIREMENTS

1.5.1 Air Infiltration Test:

Not exceed 0.10 cubic feet per minute per foot of crack length when tested at a pressure of 6.24 psf. Perform tests in accordance with ASTM E 283 with the sash in a closed and locked position.

1.5.2 Water Resistance Test:

Subject window unit to a water resistance test in accordance with ASTM E331 and ASTM E547 with no water passing the interior face of the window frame and no leakage as defined in the test method. Mount the glazed unit in its vertical position continuously supported around the perimeter and the sash placed in the fully closed and locked position. When a static pressure of 15 pounds per square foot has been stabilized, apply five gallons of water per square foot of window area to the exterior face of the unit for a period of 15 minutes.

1.5.3 Structural

Requirements for aluminum windows, terminology and standards of performance, and fabrication and workmanship are those specified and recommended in AAMA/WDMA 101/I.S.2 and applicable general recommendations published by AAMA. Conform to more stringent of specified standards and following:

1.5.3.1 Uniform Load Deflection Test:

ASTM E330 at 95 pounds per square foot; No member deflection more than 1/175 of its span. Maintain test load for a period of 10 seconds resulting in no glass breakage, permanent damage of fasteners, hardware parts, support arms, actuating mechanisms or any other damage causing the window to be inoperable.

1.5.3.2 Uniform Load Structural Test:

Apply a minimum exterior and interior uniform load of 142.5 pounds per square foot to the entire outside surface of the test unit. Maintain this test load for a period of 10 seconds. Results: No glass breakage, permanent damage of fasteners, hardware parts, support arms, actuating mechanisms, or any other damage causing the window to be inoperable. And no permanent deformation of any frame or vent member in excess of 0.2 percent of its span.

1.5.3.3 Life Cycle Test:

Per AAMA/WDMA 101/I.S.2 and AAMA 910, provide proof that the product meets the criteria including passing air and water tests at the conclusion of the cycle tests.

1.5.4 Energy / Thermal

1.5.4.1 Condensation Resistance Factor:

Test in accordance with AAMA 1503 standards and tests of thermal performance resulting in a CRF of no less than 54 using Clear-Clear insulating glass.

1.5.4.2 "U" Value Tests: (Co-efficient of Heat Transfer):

Test in accordance with AAMA 1503 Thermal Transmittance of Conduction with a 15 mph perpendicular dynamic wind: Maximum 0.58 BTU/hr/ft²/F with clear-clear glass and 0.43 BTU/hr/ft²/F using clear-Low E insulating glass.

1.5.5 Acoustic / Sound Transmission

Sound Transmission Coefficient (STC): Test in accordance with ASTM E90 with a minimum STC value of 34.

1.6 DRAWINGS

Submit the [Fabrication Drawings](#) for aluminum window units showing complete window assembly including hardware, weatherstripping, and subframe assembly details.

1.7 WARRANTY

Provide Manufacturer's standard performance guarantees or warranties that extend beyond a 1 year period.

Insulating glass units shall be guaranteed not to develop material obstruction to vision as a result of dust or film formation on the inner glass surface caused by failure of the hermetic seal or loss of dehydration, other than through glass breakage, within a 10-year period following installation. Window units shall be provided with manufacturer's standard 5-year warranty from time of SUBSTANTIAL COMPLETION. Installation shall be performed by a certified installer and in conformance with manufacturer's warranty conditions

PART 2 PRODUCTS

2.1 WINDOWS

Provide prime windows that comply with [AAMA/WDMA/CSA 101/I.S.2/A440](#) and the requirements specified herein. In addition to compliance with [AAMA/WDMA/CSA 101/I.S.2/A440](#), window framing members for each individual light of glass must not deflect to the extent that deflection perpendicular to the glass light exceeds L/175 of the glass edge length when subjected to uniform loads at specified design pressures. Provide [Structural calculations for deflection](#) to substantiate compliance with deflection requirements. Provide windows of types, performance classes, performance grades, combinations, and sizes indicated or specified. Design windows to accommodate hardware, glass, and accessories to be furnished. Each window must be a complete factory assembled unit with glass installed. Dimensions shown are minimum. Provide windows with insulating glass and thermal break necessary to achieve a minimum Condensation Resistance Factor (CRF) of 54 when tested in accordance with [AAMA 1503](#). Provide manufacturer's standard hardware fabricated from aluminum, stainless steel, carbon steel complying with [AAMA 907](#), or other corrosion-resistant material compatible with adjacent materials; designed to smoothly operate, tightly close, and securely lock windows, and sized to accommodate sash weight and dimensions.

2.1.1 Fixed Windows (F)

Windows and trim shall be of the type and size indicated and shall fully comply with the architectural drawings. Window design shall simulate a casement configuration including specific siteline dimensions as detailed on the drawings. The sash and frame perimeter shall incorporate an integral extruded bevel "putty glazed" profile to which muntin grids shall be mechanically pinned or fastened using non corrosive fasteners. Muntin Grids shall be trapezoidal shaped, neatly coped or mitered in to the perimeter bevel and securely fastened with concealed fasteners. Tape or silicone applied or "clip on" muntin grids are not permitted and glazed in

muntin grids are permitted only if the specified overall glazing depth is not reduced to accommodate the muntin base. Windows shall be cleaned, properly prepared, pretreated, and coated with the specified finish.

Provide a continuous uninterrupted thermal barrier around the entire perimeter of the frame and all sash and not be bridged by any metal conductors at any point. Provide manufacturer's standard construction which has been tested to demonstrate resistance to thermal conductance and condensation and has been tested to show adequate strength per AAMA 505

2.1.2 Glass and Glazing

The glass shall be pre-glazed by the window manufacturer. The glass shall conform to all requirements of ASTM C1036. Glass thickness shall meet or exceed the values given in ASTM E1300 for the design pressure rating of the project. At a minimum, glazing units shall be insulated Low-E consisting of 1/4 inch Annealed Clear Exterior with "soft Coat" Low-E on the #2 surface, 1/2 inch nominal airspace and nominal 1/4 inch thick clear Annealed glass. Glass shall comply with design wind loads for the project location.

Specified insulated glazing units (IGUs) at exterior windows and storefront at exterior openings are to comply with UFC 4-010-01, Section 3-11.1 - Standard 10 - Glazing. IGU are to include in inner pane with 1/4 inch nominal laminated glass consisting of two 1/8 inch glass panes bonded together with a min. of 0.030 in. interlayer of material that has typically been used in blast resistant window applications. (Do not specify polycarbonate panes.) See also the bite requirements for the frames and sealing beads in UFC 4-010-01 Section 3-11.1 - Standard 10.

Materials are specified in Section 08 81 00 GLAZING.

2.1.3 Caulking and Sealing

Provide suitable type in accordance with applicable portions of GANA Glazing Manual and as specified in Section 07 92 00. Setting materials shall match the window finish, be non-staining, and not require painting. Other materials that will be exposed to view and unpainted shall be black, white or neutral color as specified by the architect. Provide structural silicone glazing compound with a low modulus and blast tested.

2.2 FABRICATION

Fabrication of window units must comply with AAMA/WDMA/CSA 101/I.S.2/A440.

2.2.1 Provisions for Glazing

Design windows and rabbets suitable for glass thickness shown or specified.

2.2.2 Fasteners

Use window manufacturer's standard for windows, trim, and accessories. Self-tapping sheet-metal screws are not acceptable for material more than 1/16 inch thick.

2.2.3 Adhesives

Provide joint sealants as specified in Section 07 92 00 JOINT SEALANTS.

For interior application of joint sealants, comply with applicable regulations regarding reduced VOC's, and as specified in Section 07 92 00 JOINT SEALANTS.

2.2.4 Drips and Weep Holes

Provide continuous drips over heads of top ventilators. Where fixed windows adjoin ventilators, drips must be continuous across tops of fixed windows. Provide drips and weep holes as required to return water to the outside.

2.2.5 Mullions and Transom Bars

Provide mullions between multiple window units to resist two times (2X) glazing resistance in accordance with ASTM F2248 and ASTM E1300. Provide mullions with a thermal break. Secure mullions and transom bars to adjoining construction and window units in such a manner as to permit expansion and contraction and to form a weathertight joint. Provide mullion covers on the interior and exterior to completely close exposed joints and recesses between window units and to present a neat appearance.

2.2.6 Trim

Panning trim shall be designed to adequately cover original window framing after removal of the existing replacement aluminum windows. Panning trim shall be wrap around design attached to a perimeter panning leg of the window main frame. Maintain sitelines as close to those detailed as possible.

Two-Piece Interior Snap trim for Anchorage of new aluminum window units shall consist of a continuous extruded aluminum base clip and a "snap on" extruded aluminum cover finished to match the windows. Snap trim shall comply with required anchorage conditions and structural loads.

2.2.7 Accessories

Provide windows complete with necessary hardware, fastenings, clips, fins, anchors, glazing beads, and other appurtenances necessary for complete installation and proper operation.

2.2.7.1 Fasteners

Provide concealed anchors of the type recommended by the window manufacturer for the specific type of construction. Anchors and fasteners must be compatible with the window and the adjoining construction. Provide a minimum of three anchors for each jamb located approximately 6 inches from each end and at midpoint.

2.2.7.2 Window Anchors

Anchoring devices for installing windows must be made of aluminum, cadmium-plated steel, stainless steel, or zinc-plated steel conforming to AAMA/WDMA/CSA 101/I.S.2/A440.

2.2.8 Finishes

Comply with NAAMM's "Metal Finishes Manual" for applying and designating finishes. Exposed aluminum surfaces must be factory finished with an organic coating. Color must be selected from manufacturer's standard

color range. All windows must have the same finish.

2.2.8.1 Organic Coating

Clean and prime exposed aluminum surfaces. Provide a high-performance finish in accordance with AAMA 2605 with total dry film thickness of not less than 1.2 mils.

2.3 THERMAL-BARRIER WINDOWS

Provide thermal-barrier windows, complete with accessories and fittings, where indicated.

Specify material and construction except as follows:

- a. Aluminum alloy must be 6063-T6.
- b. Frame construction, must be factory-assembled and factory-sealed inner and outer aluminum completely separated from metal-to-metal contact. Join assembly by a continuous, concealed, low conductance divider housed in an interlocking extrusion of the inner frame. Metal fasteners, straps, or anchors must not bridge the connection between the inner and outer frame.

2.4 MULLIONS

Provide mullions between multiple-window units where indicated.

Provide profiles for mullions and mullion covers, reinforced as required for the specified wind loading, and securely anchored to the adjoining construction. Mullion extrusion will include serrations or pockets to receive weatherstripping, sealant, or tape at the point of contact with each window flange.

Mullion assembly must include aluminum window clamps or brackets screwed or bolted to the mullion and the mullion cover.

Mullion cover must be screw-fastened to the mullion unless otherwise indicated.

Mullion reinforcing members must be fabricated of the materials specified in AAMA/WDMA/CSA 101/I.S.2/A440 and meet the specified design loading.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Method of Installation

Install in accordance with the window manufacturer's printed instructions and details. Build in windows as the work progresses or install without forcing into prepared window openings. Set windows at proper elevation, location, and reveal; plumb, square, level, and in alignment; and brace, strut, and stay properly to prevent distortion and misalignment. Protect ventilators and operating parts against accumulation of dirt and building materials by keeping ventilators tightly closed and locked to frame. Bed screws or bolts in sill members, joints at mullions, contacts of windows with sills, built-in fins, and subframes in mastic sealant of a type recommended by the window manufacturer. Install and caulk windows in a

manner that will prevent entrance of water and wind. Fasten insect screens securely in place.

Any materials that show visual evidence of biological growth due to the presence of moisture must not be installed on the building project.

3.1.2 Dissimilar Materials

Where aluminum surfaces are in contact with, or fastened to masonry, concrete, wood, or dissimilar metals, except stainless steel or zinc, protect the aluminum surface from dissimilar materials as recommended in the Appendix to [AAMA/WDMA/CSA 101/I.S.2/A440](#). Do not coat surfaces in contact with sealants after installation with any type of protective material. Do not apply coatings or lacquers to surfaces to which caulking and glazing components must adhere.

3.1.3 Anchors and Fastenings

Make provision for securing units to each other, to masonry, and to other adjoining construction. Windows installed in masonry walls must have head and jamb members designed to recess into masonry wall not less than [7/16 inch](#).

3.1.4 Adjustments After Installation

After installation of windows and completion of glazing and field painting, adjust all ventilators and hardware to operate smoothly and to provide weathertight sealing when ventilators are closed and locked. Lubricate hardware and operating parts as necessary. Adjust double hung windows to operate with maximum applied force of 25 pounds in either direction, not including breakaway friction force. Verify that products are properly installed, connected, and adjusted.

3.2 CLEANING

Clean interior and exterior surfaces of window units of mortar, plaster, paint spattering spots, and other foreign matter to present a neat appearance, to prevent fouling of weathering surfaces and weather-stripping, and to prevent interference with the operation of hardware. Replace all stained, discolored, or abraded windows that cannot be restored to their original condition with new windows.

-- End of Section --

SECTION 08 71 00

DOOR HARDWARE
02/16, CHG 4: 02/22

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM E283 (2019) Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen

BUILDERS HARDWARE MANUFACTURERS ASSOCIATION (BHMA)

ANSI/BHMA A156.1 (2021) Butts and Hinges

ANSI/BHMA A156.2 (2017) Bored and Preassembled Locks and Latches

ANSI/BHMA A156.3 (2020) Exit Devices

ANSI/BHMA A156.4 (2013) Door Controls - Closers

ANSI/BHMA A156.5 (2020) Cylinder and Input Devices for Locks

ANSI/BHMA A156.6 (2021) Architectural Door Trim

ANSI/BHMA A156.7 (2016) Template Hinge Dimensions

ANSI/BHMA A156.8 (2021) Door Controls - Overhead Stops and Holders

ANSI/BHMA A156.10 (2017) Power Operated Pedestrian Doors

ANSI/BHMA A156.13 (2017) Mortise Locks & Latches Series 1000

ANSI/BHMA A156.15 (2021) Release Devices Closer Holder, Electromagnetic and Electromechanical

ANSI/BHMA A156.16 (2018) Auxiliary Hardware

ANSI/BHMA A156.17 (2019) Self Closing Hinges & Pivots

ANSI/BHMA A156.18 (2020) Materials and Finishes

ANSI/BHMA A156.19 (2013) Power Assist & Low Energy Power Operated Doors

ANSI/BHMA A156.21 (2019) Thresholds

ANSI/BHMA A156.22	(2021) Gasketing
ANSI/BHMA A156.25	(2013) Electrified Locking Devices
ANSI/BHMA A156.26	(2012) Continuous Hinges
ANSI/BHMA A156.31	(2013) Electric Strikes and Frame Mounted Actuators
ANSI/BHMA A156.36	(2010) Auxiliary Locks

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023) National Electrical Code
NFPA 72	(2022; ERTA 22-1) National Fire Alarm and Signaling Code
NFPA 80	(2022) Standard for Fire Doors and Other Opening Protectives
NFPA 101	(2021; TIA 21-1) Life Safety Code
NFPA 252	(2022) Standard Methods of Fire Tests of Door Assemblies

STEEL DOOR INSTITUTE (SDI/DOOR)

SDI/DOOR A250.8	(2017) Specifications for Standard Steel Doors and Frames

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

36 CFR 1191	Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines

UNDERWRITERS LABORATORIES (UL)

UL Bld Mat Dir	(updated continuously online) Building Materials Directory

1.2 SUBMITTALS

Government approval is required for submittals . Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Manufacturer's Detail Drawings

Verification of Existing Conditions

Hardware Schedule

Keying System

SD-03 Product Data

Hardware Items

SD-08 Manufacturer's Instructions

Installation

SD-10 Operation and Maintenance Data

Hardware Schedule Items, Data Package 1

SD-11 Closeout Submittals

Key Bitting

1.3 SHOP DRAWINGS

Submit [manufacturer's detail drawings](#) indicating all hardware assembly components and interface with adjacent construction. Indicate power components and wiring coordination for electrified hardware. Base shop drawings on verified field measurements and include [verification of existing conditions](#).

1.4 PRODUCT DATA

Indicate fire-ratings at applicable components. Provide documentation of ABA/ADA accessibility compliance of applicable components, as required by [36 CFR 1191](#) Appendix D - Technical.

1.5 [HARDWARE SCHEDULE](#)

Provide Hardware Item List and Hardware Schedule containing the following information, and additional information as needed to identify the complete make up of each hardware set and its application to each opening:

1.5.1 Hardware Item List:

- a. Hardware Type
- b. Item Number
- c. Quantity
- d. Size(s)
- e. Reference Publication / Type Number
- f. Manufacturer's Name / Catalog Number
- g. Key Control Symbols
- h. UL Mark (If fire rated and listed)
- i. BHMA Finish(es)
- j. Remarks

1.5.2 Hardware Schedule

- a. Hardware Set Number
- b. Opening Number(s)
- c. Opening Description (single/double leaf, hand, size, door/frame material)
- d. Fire Rating
- e. Sound Rating
- f. Hardware Items
- g. Quantity
- h. Size
- i. BHMA Finish
- j. Remarks

In addition, submit hardware schedule data package 1 in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

1.6 KEY BITTING CHART REQUIREMENTS

1.6.1 Requirements

Submit [key bitting](#) charts to the Contracting Officer prior to completion of the work. Include:

- a. Complete listing of all keys (e.g. AA1 and AA2).
- b. Complete listing of all key cuts (AA1-123456, AA2-123458).
- c. Tabulation showing which key fits which door.
- d. Copy of floor plan showing doors and door numbers.
- e. Listing of 20 percent more key cuts than are presently required in each master system.

1.7 QUALITY ASSURANCE

1.7.1 Hardware Manufacturers and Modifications

Provide, as far as feasible, locks, hinges, and closers of one lock, hinge, or closer manufacturer's make. Modify hardware as necessary to provide features indicated or specified.

1.7.2 Key Shop Drawings Coordination Meeting

Prior to the submission of the key shop drawing, the Contracting Officer, Contractor, Door Hardware Subcontractor, using Activity and Base Locksmith must meet to discuss and coordinate key requirements for the facility.

1.8 DELIVERY, STORAGE, AND HANDLING

Deliver hardware in original individual containers, complete with necessary appurtenances including fasteners and instructions. Mark each individual container with item number as shown on hardware schedule. Deliver permanent keys to the Contracting Officer, either directly or by certified mail. Deliver construction master keys with the locks.

PART 2 PRODUCTS

2.1 TEMPLATE HARDWARE

Hardware applied to metal or to prefinished doors must be manufactured using a template. Provide templates to door and frame manufacturers in accordance with ANSI/BHMA A156.7 for template hinges. Coordinate hardware items to prevent interference with other hardware.

2.2 HARDWARE FOR FIRE DOORS AND EXIT DOORS

Provide all hardware necessary to meet the requirements of NFPA 72 for door alarms, NFPA 80 for fire doors, NFPA 101 for exit doors, NFPA 252 for fire tests of door assemblies, ABA/ADA accessibility requirements, and all other requirements indicated, even if such hardware is not specifically mentioned in paragraph HARDWARE SCHEDULE. Provide Underwriters Laboratories, Inc. labels for such hardware in accordance with UL Bld Mat Dir or equivalent labels in accordance with another testing laboratory approved in writing by the Contracting Officer.

2.3 HARDWARE ITEMS

Clearly and permanently mark with the manufacturer's name or trademark, hinges, pivots, locks, latches, exit devices, bolts and closers where the identifying mark is visible after the item is installed. For closers with covers, the name or trademark may be beneath the cover. Coordinate electrified door hardware components with corresponding components specified in Division 28 ELECTRONIC SECURITY SYSTEMS (ESS).

2.3.1 Hinges

Provide in accordance with ANSI/BHMA A156.1. Unless scheduled otherwise, provide 1½ pair full mortise type, exterior doors 5 x 4½, interior doors 4½ x 4, F-series, typically #F-179, typically 1900 Series standard weight, template layout, adjusting as follows for each door leaf:

- a. Typical outswing exterior doors: Supply in wrought brass/finish US2C x P with NRP
- b. Exterior doors without 4 feet of cover: Supply in wrought brass
- c. Exterior entrance doors, locker areas, gang toilets and elsewhere noted: Supply heavy wt.
- d. Typical interior wood doors: Series and finish heretofore specified
- e. Doors with closers: Add ball-bearing or anti-friction feature
- f. Doors over 3' wide: Supply in heavy weight ball bearing (4½ x 4½ interior)

- g. Doors to staff and public toilets: Supply in heavy weight 4½ x 4½
- h. Where reinforcing pivots occur: Supply in heavy weight (4½ x 4½ interior)
- i. Locker, dishwash, and kitchen areas: Provide in wrought brass
Where wood frames occur: Supply butts 4 x 4
- j. Where doors (or closer) will be racked by adjacent wall, trim, base condition, 180 Degree layback, or double-egress frame: Provide wide throw type.
- k. See Hollow Metal Section for caution regarding universal butt-prep.
- l. Stainless steel may be substituted for brass butts US26 or 26d.
- m. Antifriction bearings are acceptable where ball-bearing is noted.

2.3.1.1 Protection Devices

Provide full height hand and finger protection device at the hinge-side area opening of doors as indicated. Provide hinge-side protection devices on both sides of doors, covering hinges and space between door and frame when doors are in the open position. The installed device must push hand and fingers out of the opening and away from a crushing hazard.

2.3.2 Continuous Hinges

Where continuous hinges are required, provide in accordance with ANSI/BHMA A156.26.

2.3.3 Spring Hinges

Provide in accordance with ANSI/BHMA A156.17.

2.3.4 Locks and Latches

- a. At exterior locations provide locksets of full stainless steel type 302 or 304 construction including fronts, strike, escutcheons, knobs, bolts and all interior working parts. Marine Grade I, fully non-ferrous.
- b. In non-air-conditioned interior environments or humid interior environments, provide interior locksets on the same Marine Grade I, fully non-ferrous as exterior locksets.

2.3.4.1 Mortise Locks and Latches

Provide in accordance with ANSI/BHMA A156.13, Series 1000, Operational Grade 1, Security Grade 2; mortise type, with 1-1/4 inch face plates, standard bevel, and 2-3/4 inch backset. Strikes ASA standard (4-7/8 inch), handed with curved lip (one hole at latch-only functions); 1-3/16 inch lip length at HM frames, 1-1/2 inch at demount frames. All strikes (including mortise deadbolts) to have box housing. Provide cast turn pieces in design selected. Latch bolt to be 2-piece anti-friction type. Supply with #07 solid forged brass (or stainless steel) levers and L-Standard thru-bolting forged (or cast) brass escutcheons. Provide knobs and roses of mortise locks with screwless shanks and no exposed screws.

Latch bolts shall have $\frac{3}{4}$ " throw ($\frac{3}{4}$ " on A-labeled single leaf and at all labeled pairs). Mortise deadbolts shall have $2\frac{3}{4}$ " backset. All deadbolts at pairs shall have 1" throw.

At pairs of hollow metal doors with an astragal, provide a strike with a straight lip that will fit flush with the door face (and thus not require that the astragal be slotted). Refer to HM Section.

2.3.4.2 Bored Locks and Latches

Provide in accordance with ANSI/BHMA A156.2, Series 4000, Grade 1.

2.3.4.3 Auxiliary Locks

Provide in accordance with ANSI/BHMA A156.36, Grade 1.

2.3.5 Exit Devices

Provide in accordance with ANSI/BHMA A156.3, Grade 1. Provide adjustable strikes for rim type and vertical rod devices. Provide open back strikes for pairs of doors with mortise and vertical rod devices. Provide touch bars in lieu of conventional crossbars and arms. Provide escutcheons not less than 7 by 2-1/4 inch.

2.3.6 Cylinders and Cores

Provide cylinders and cores with seven pin tumblers. Provide cylinders from the products of one manufacturer, and provide cores from the products of one manufacturer. Rim cylinders, mortise cylinders, and knobs of bored locksets have interchangeable cores which are removable by special control keys. Stamp each interchangeable core with a key control symbol in a concealed place on the core.

Supply removable cylinders as scheduled, keyed with typical locks. Cams, rings, collars, lengths, etc. shall be appropriate for the lock with which it is to function; coordinate with other Sections. Cylinder trim shall be a straight or slightly tapered recessed cylinder ring (no compression rings allowed). Where cylinder dogging is specified or standard for exit devices, supply appropriate master keyed cylinder.

2.3.7 Electrified Hardware

Comply with the requirements of NFPA 70 for wiring of electrified hardware.

2.3.7.1 Electric Strikes and Frame Mounted Actuators

Provide in accordance with ANSI/BHMA A156.31, Grade 1. Provide electric strikes and actuators as required to meet operational requirements. Provide electric strikes that release automatically during power failure. Provide strikes and actuators with a minimum opening force of 2300 pounds.

Provide facility interface devices that use direct current (dc) power to energize the solenoids. Provide electric strikes and actuators that incorporate end-of-line resistors to facilitate line supervision by the system. If not incorporated into the electric strike or local controller, provide metal oxide resistors (MOVs) to protect the controller from reverse current surges.

2.3.7.1.1 Solenoid

Provide actuating solenoid for strikes and actuators that are rated for continuous duty, cannot dissipate more than 12 Watts and must operate on 12 or 24 Volts dc. Inrush current cannot exceed 1 ampere and the holding current cannot be greater than 500 milliamperes. Actuating solenoid must move from fully secure to fully open positions in less than 500 milliseconds.

2.3.7.1.2 Signal Switches

Provide strikes and actuators with signal switches to indicate to the system when the bolt is not engaged or the strike mechanism is unlocked. Signal switches must report a forced entry to the system.

2.3.7.1.3 Tamper Resistance

Provide strike guards that prevent tampering with the latch bolt of the locking hardware or the latch bolt keeper of the electric strike. Strike guards to bolt through the door using tamper resistant screws. Provide strike guards made of 1/8 inch thick brass and that are 11-1/14 inch high by 1-5/8 inch wide, with a minimum 5/32 inch wide offset.

2.3.7.1.4 Coordination

Provide electric strikes and actuators of a size, weight and profile compatible with each specified door frame. Field verify installation clearances prior to procurement.

2.3.7.1.5 Mounting Method

Provide electric strikes and actuators suitable for use with single and double doors, with mortise or rim type hardware specified, and for right or left hand mounting as specified. In double door installations, locate the lock in the active leaf and monitor the fixed leaf.

2.3.7.2 Electrified Mortise Locks

Provide in accordance with ANSI/BHMA A156.25, Grade 1. Provide electrified mortise locks that release automatically during power failure. Provide facility interface devices that use dc power to energize solenoids. Provide solenoids, resistors, and signal switches in accordance with paragraph ELECTRIC STRIKES AND FRAME MOUNTED ACTUATORS.

2.3.7.2.1 Power Transfer Hinges

Provide power transfer hinges with each electrified lock that route power and monitoring signals from the lockset to the door frame. Coordinate power transfer hinges with door frames.

2.3.7.3 Power Operated Pedestrian Door Hardware

Provide in accordance with ANSI/BHMA A156.10, Grade 1.

2.3.7.4 Release Devices

In accordance with ANSI/BHMA A156.15, Grade 1.

2.3.7.5 Power Assist and Low Energy Power Operated Doors

Provide in accordance with ANSI/BHMA A156.19, Grade 1.

Unit shall be surface mounted on swing-out (exterior) side of the door, and shall be sized and coordinated with door swing, size, frame and related hardware. It shall allow the door to function in a manual mode with or without power applied. Adjustable features shall include open speed, open check, close speed and delay time (delay time shall apply only to push button operation).

Automatic door opening shall be triggered whenever door is displaced more than 3 degrees. In addition, door shall be equipped with stainless steel handicap push plates mounted in frame mull and hard-wired to the operator. Unit shall operate at 120v and shall be equipped with a disconnect switch built into the header. Wiring to each header, and all conduit and back-boxes shall be provided by the Electrical Subcontractor.

Housing header shall be continuous wall-to-wall over the entire entrance battery, clear anodized for field painting to match door frame. Coordinate pre-painting of portions which are visible but inaccessible after erection; closer arms shall be lacquered aluminum.

Furnish stainless steel BEA handicap actuator push plate with text and logo (10PBJ1) for mounting on the exterior and interior. Where mounted on door jamb provide BEA handicap actuator push plate series PBJ.

Provide toggle switch mounted on frame to disable operator when needed.

2.3.8 Keying System

System is to be an extension of the existing Maxwell AFB master key system. Master key, key alike, and match existing groups as directed. New key bittings shall be an extension of factory key records maintained by Best. Provide key cabinet as specified.

If requested by Owner, match keyway of existing locksets (if any) at the facility of the brand being supplied.

Prepare keying schedules after detailed conferences with Owner and Architect. In the absence of specific instructions, do not include any keying proposal with the hardware submittal.

Hardware dealers who cannot supply the specified factory prepared MK cylinders, shall include in their bid an allowance of \$90.00 per cylinder with which to purchase the specified material. If the allowance proves inadequate, the Owner, at his option, may choose to increase the allowance or directly purchase the cylinders through a franchised dealer and supply these to the Contractor. In any case, the contractor shall prepare the appropriate order, receive and verify the correctness of the MK system, and install the cylinder as part of his work.

2.3.8.1 Construction Keying:

Provide temporary brass construction use cores for all locks and exit devices for the project. Provide 12 construction keys. At the completion of the project the general contractor shall remove construction cores and install all permanent cores. Construction cores shall be returned to the hardware supplier by the general contractor.

2.3.9 Lock Trim

Provide cast, forged, or heavy wrought construction and commercial plain design for lock trim.

2.3.9.1 Knobs and Roses

Provide in accordance with ANSI/BHMA A156.2 and ANSI/BHMA A156.13 for knobs, roses, and escutcheons. For unreinforced knobs, roses, and escutcheons, provide a 0.050 inch thickness. For reinforced knobs, roses, and escutcheons, provide an outer shell thickness of 0.035 inch and a combined total thickness of 0.070 inch, except at knob shanks. Provide knob shanks 0.060 inch thick.

2.3.9.2 Lever Handles

Provide lever handles where indicated in the Hardware Schedule. Provide in accordance with ANSI/BHMA A156.3 for mortise locks of lever handles for exit devices. Provide lever handle locks with a breakaway feature (such as a weakened spindle or a shear key) to prevent irreparable damage to the lock when force in excess of that specified in ANSI/BHMA A156.13 is applied to the lever handle. Provide lever handles return to within 1/2 inch of the door face.

2.3.9.3 Identification for the Blind:

Knobs, levers, pulls, panic bars, etc. on doors leading to possible danger for a blind person shall have a knurled surface per ANSI A117.1. Levers and pulls leading to such places may have a concealed abrasive coating if knurling is not available from the manufacturer; submit sample. Provide for Mechanical, Electrical and Communication Equip Room Doors.

2.3.10 Keys

Furnish 2 keys with each cylinder plus 2 keys per change combination, 4 master keys of each cut, and 4 grand master keys. Make provisions for future expansion of system up to 100 changes under each submaster. Key alike groups and match existing groups as directed. Manufacture only those keys as required; all keys must be accounted for. Send master keys and list of key change numbers by registered mail direct to the Architect for presentation to the Owner.

Supply keys with change number stamped on or with a 2-letter code as directed (request code if change numbers are not to be utilized).

Die stamp each key with set symbol. Stamp "DO NOT DUPLICATE" on all but one key of any given cut. (Box and ship unstamped keys separate from locksets for installation in key cabinet as file/duplication use keys).

2.3.11 Door Bolts

Flush mortise type of cast, forged or extruded brass with delayed bolt action for easy operation, 12" long (top bolts 18" long at 8-foot doors, 24" at 9-foot doors). Not scheduled; as typical application, supply head bolts for edge of standing leaf of all double doors. Supply head and foot bolts for double exterior doors, fire rated doors and storage room doors.

Where surface bolts are scheduled, provide UL approved heavy-duty surface

bolts equal to GJ 1631 x 12"-foot bolt and 1632 x 12" head bolt (20" at doors over 90"; 32" at doors over 96").

Provide automatic type flush head and foot bolts as scheduled. Include guides, plates, etc. to complete the installation.

Provide dustproof type floor strikes except where a drilled threshold will substitute. Provide box housing for head plates.

2.3.12 Closers

Provide in accordance with ANSI/BHMA A156.4, Series C02000, Grade 1, with PT 4C. Provide with brackets, arms, mounting devices, fasteners, full size covers, except at storefront mounting, and other features necessary for the particular application. Size closers in accordance with manufacturer's printed recommendations, or provide multi-size closers, Sizes 1 through 6, and list sizes in the Hardware Schedule. Provide manufacturer's 10 year warranty.

2.3.12.1 Identification Marking

Engrave each closer with manufacturer's name or trademark, date of manufacture, and manufacturer's size designation in locations that will be visible after installation.

2.3.13 Overhead Holders

Provide in accordance with ANSI/BHMA A156.8. Supply each device with opening and dead stop degree as appropriate to facilitate traffic and protect door and hardware from damage. Secure to door leaves with sex bolts. Provide special brackets where necessary to clear sound or air stripping or special closer shoes. Holders provided on interior doors to substitute for wall stop

2.3.14 Door Protection Plates

Provide in accordance with ANSI/BHMA A156.6.

Laminated plastic 1/8" thick, (1/2 depth bevel), color as selected. Meet ANSI Standard J100 except that plastic is not required to be balanced. Kick, and mop plates one inch shorter than space between jamb or stops as applicable. Coordinate plates with door lights and conflicting hardware. Submit a sample reflecting color, thickness, edge, screw prep and screw.

Unless scheduled otherwise, provide as follows on wood veneered and hollow metal doors:

- A. On doors with closers: 8" kick plate on push side (not required on outswing doors of mechanical and electrical rooms of 200 sf and smaller).
- B. On double-acting doors:
 - 8" x 16" push plate each side
 - 10" kick plate each side
 - 12" armour plate each side
- C. Double-egress doors: 8" kick plate each face
- D. Doors sides adjacent to hard tile floor or door sides facing a toilet, shower, food service, or locker area: 6" mop plate (if no kickplate).

- E. Supply armor plates where scheduled, 42" high (35" high where mortise locks occur)

Apply plastic push plates to conceal any thru-bolts connecting a device on the opposite side; make minor adjustments in plate height to accomplish concealment. Secure with countersunk oval head phillips-drive stainless steel or brass screw finished as indicated

2.3.15 Door Stops and Silencers

Provide door stops in accordance with ANSI/BHMA A156.16. Do not install floor stops unless the Architect determines no other type is practical. No stop is required on interior doors of low frequency use where the nearest obstruction is well beyond 120 Degrees and a regular arm closer occurs. Unless specifically scheduled, no stop is required where a door holder or wall type electric holder occurs.

Silencers Type L03011. Provide three silencers for each single door, two for each pair.

2.3.16 Thresholds

Provide in accordance with ANSI/BHMA A156.21. Use J35100, with vinyl or silicone rubber insert in face of stop, for exterior doors opening out, unless specified otherwise.

2.3.17 Weatherstripping Gasketing

Provide in accordance with ANSI/BHMA A156.22. Provide the type and function designation where specified in paragraph HARDWARE SCHEDULE. Provide a set to include head and jamb seals, sweep strips, and, for pairs of doors, astragals. Air leakage of weatherstripped doors not to exceed 0.5 cubic feet per minute of air per square foot of door area when tested in accordance with ASTM E283. Provide weatherstripping with one of the following:

2.3.17.1 Extruded Aluminum Retainers

Extruded aluminum retainers not less than 0.050 inch wall thickness with vinyl, neoprene, silicone rubber, or polyurethane inserts. Provide clear (natural) anodized aluminum.

2.3.17.2 Interlocking Type

Zinc or bronze not less than 0.018 inch thick.

2.3.17.3 Spring Tension Type

Spring bronze or stainless steel not less than 0.008 inch thick.

2.3.18 Rain Drips

Provide at Mechanical, Communication and Executive Dining Room door heads: Extend full width of leaf or recess, as appropriate for application, 8" past jamb if no recess occurs.

Provide in accordance with ANSI/BHMA A156.22. Provide extruded aluminum rain drips, not less than 0.08 inch thick, clear anodized finish. Provide

the manufacturer's full range of color choices to the Contracting Officer for color selection. Set drips in sealant and fasten with stainless steel screws.

2.3.19 Auxiliary Hardware (Other than locks)

Provide in accordance with ANSI/BHMA A156.16, Grade 1.

2.3.20 Special Tools

Provide special tools, such as spanner and socket wrenches and dogging keys, as required to service and adjust hardware items.

2.3.21 Hardware Not Scheduled:

Provide hardware as scheduled for a similar door application. If no other door is similar, assume typical lockset application without closer. Supply closer if door carries a fire rating.

2.4 FASTENERS

Provide fasteners of type, quality, size, and quantity appropriate to the specific application. Fastener finish to match hardware. Provide stainless steel or nonferrous metal fasteners in locations exposed to weather. Verify metals in contact with one another are compatible and will avoid galvanic corrosion when exposed to weather.

2.5 FINISHES

Provide in accordance with ANSI/BHMA A156.18.

Supply hardware with the following:

Lock Trim	-dull chrome (US26d) -polished chrome (US26) in toilet, food service, locker areas
Closers (surface and concealed)	-dark bronze lacquer finish typically -aluminum lacquer finish where occurs on natural aluminum storefront
Butts	-plated finish to match locks typically -prime finish where hollow metal doors occur
Holders	-GJ-90 plated to match locks
Bumpers & Stops	-plated finish to match locks typically
Surface and Flush Bolts	-plated to match locksets
Coordinators and removable mulls	-prime finish
Push/Pull Plates	-plated to match locks
Exit Devices	-plated to match locks

2.6 KEY CABINET AND CONTROL SYSTEM

Provide in accordance with ANSI/BHMA A156.5, Type required to yield a capacity (number of hooks) 50 percent greater than the number of key changes used for door locks.

PART 3 EXECUTION

3.1 INSTALLATION

Provide hardware in accordance with manufacturers' printed installation instructions. Fasten hardware to wood surfaces with full-threaded wood screws or sheet metal screws. Provide machine screws set in expansion shields for fastening hardware to solid concrete and masonry surfaces. Provide toggle bolts where required for fastening to hollow core construction. Provide through bolts where necessary for satisfactory installation.

3.1.1 Weatherstripping Installation

Provide full contact, weathertight seals that allow operation of doors without binding the weatherstripping.

3.1.1.1 Stop Applied Weatherstripping

Fasten in place with color matched sheet metal screws not more than 9 inch on center after doors and frames have been finish painted.

3.1.1.2 Interlocking Type Weatherstripping

Provide interlocking, self adjusting type on heads and jambs and flexible hook type at sills. Nail weatherstripping to door 1 inch on center and to heads and jambs at 4 inch on center.

3.1.1.3 Spring Tension Type Weatherstripping

Provide spring tension type on heads and jambs. Provide bronze nails with bronze. Provide stainless steel nails with stainless steel. Space nails not more than 1-1/2 inch on center.

3.1.2 Threshold Installation

Extend thresholds the full width of the opening and notch end for jamb stops. Set thresholds in a full bed of sealant and anchor to floor with cadmium-plated, countersunk, steel screws in expansion sleeves. For aluminum thresholds placed on top of concrete surfaces, coat the underside surfaces that are in contact with the concrete with fluid applied waterproofing as a separation measure prior to placement.

3.2 FIRE DOORS AND EXIT DOORS

Provide hardware in accordance with NFPA 72 for door alarms, NFPA 80 for fire doors, NFPA 101 for exit doors, and NFPA 252 for fire tests of door assemblies.

3.3 HARDWARE LOCATIONS

Provide in accordance with SDI/DOOR A250.8, unless indicated or specified otherwise.

- a. Kick and Armor Plates: Push side of single-acting doors. Both sides of double-acting doors.
- b. Mop Plates: Bottom flush with bottom of door.

3.4 KEY CABINET AND CONTROL SYSTEM

Locate where directed. Tag one set of file keys and one set of duplicate keys. Place other keys in appropriately marked envelopes, or tag each key. Provide complete instructions for setup and use of key control system. On tags and envelopes, indicate door and room numbers or master or grand master key.

3.5 FIELD QUALITY CONTROL

After installation, protect hardware from paint, stains, blemishes, and other damage until acceptance of work. Submit notice of testing 15 days before scheduled, so that testing can be witnessed by the Contracting Officer. Adjust hinges, locks, latches, bolts, holders, closers, and other items to operate properly. Demonstrate that permanent keys operate respective locks, and give keys to the Contracting Officer. Correct, repair, and finish, errors in cutting and fitting and damage to adjoining work.

3.6 HARDWARE SETS

Provide hardware for aluminum doors under this section. Deliver Hardware templates and hardware, except field applied hardware, to the aluminum door and frame manufacturer for use in fabricating doors and frames.

3.6.1 Guide for Preparing Schedule:

Provide items for each leaf except as obvious otherwise. Schedule and provide butts, bumpers, plates, bolts, etc. as specified hereinbefore. Room listings identify doors, not secure sides.

Set No. 1 (Doors 106A, 111C, 111D, 125)	Passage Set L9010 Surface Closer
Set No. 2 (Doors 127, 128)	Passage Set L9010 Overhead Stop
Set No. 3 (Doors 135, 136)	Lockset L9080HD Surface Closer
Set No. 4 Windows (Doors 122A, 122B, 130B, 130D)	
Set No. 5 Cased Opening (Openings 117, 120, 121)	
Set No. 6 All Hardware by Door Manufacturer (Openings 106B, 111A, 111B)	
Set No. 7 (Openings 107, 109, 122, 123)	L9456HD
Set No. 8 (Doors 105, 118, 119)	Privacy Set L9040 L283-722 Surface closer
Set No. 9 (Doors 101, 103)	Push plate Pull plate Surface Closer (template closer)

for max degree of swing)

Set No. 10 (Pair Doors 130C)	Push plate Pull plate Surface Closer SCUSH
Set No. 11 (Pair Doors 116)	Exit Device 9847E0-990E0-SNB Exit Device CD-9847TLOP-374T-990DT-SNB Surface Closer H-SCUSH Armor Plate Cast Threshold
Set No. 12 (Pair Doors B-1)	Removable Mullion KR4954 Exit Device 98E0-990E0-SNB Exit Device 98NL-990NL-SNB Cylinders As Required Surface Closer H-SCUSH
Set No. 13 (Pair Doors M1, M2A)	Flush Bolts Lockset L9480HD Surface Closer CUSH
Set No. 14 (Doors C1, M2B, 134, 137)	Lockset L9480HD Surface Closer CUSH
Set No. 15 (Pair Doors 129)	Continuous Gear Hinge Ives 112HD Removable Mullion KR4954 Rim Exit Device Von Duprin 98-E0-299 (Each Door Leaf) Cylinders As Required Concealed Overhead Stop GJ 100S Surface Closer LCN 4021 w/drop plate 18G Threshold Weather Seals (By Frame/Door Supplier)
Set No. AL-01 (Doors 100B, 131A)	Continuous Gear Hinge Ives 112HD Power Transfer Von Duprin EPT10-CON Rim Exit Device Von Duprin CD-LX-35A-NL-OP-388-CON Cylinders As Required Low-Energy Door Operator Handicapped Actuator Push Paddles Offset Pull Ives 9264F-18-12-A Metal Threshold Weather Seals (By Frame/Door Supplier) Wire Diagram

Operational Description:

Exterior and interior Handicapped actuator paddles operable only when exit device latch bolt is mechanically dogged. Exit device latch bolt monitor switch (LX) wired into actuator push button circuit.

Set No. AL-02 (Doors 100A, 130A, 131B)	Continuous Gear Hinge Ives 112HD Rim Exit Device Von Duprin-CD-35A-NL-OP-388 Cylinders As Required Offset Pull Ives 9264F-18-12-A

	Concealed Overhead Stop GJ 100S Surface Closer LCN 4021 w/drop plate 18G Threshold Weather Seals (By Frame/Door Supplier)
Set No. AL-03 (Pair Doors 108)	Continuous Gear Hinge Ives 112HD Power Transfer Von Duprin EPT10-CON Removable Mullion KR4954 Rim Exit Device Von Duprin-CD35A-E0 Rim Exit Device Von Duprin-CD-LX-35A-NL-OP-388 Cylinders As Required Concealed Overhead Stops GJ 100S Surface Closer LCN 4021 w/drop plate Low-Energy Door Operator Handicap Actuator Push Paddles Offset Pull Ives 9264F-18-12-A Metal Threshold Weather Seals (By Frame/Door Supplier) Wire Diagram

Operational Description:

Exterior and interior Handicapped actuator paddles operable only when exit device latch bolt is mechanically dogged. Exit device latch bolt monitor switch (LX) wired into actuator push button circuit.

-- End of Section --

SECTION 08 81 00

GLAZING
05/19

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION (AAMA)

AAMA 800 (2016) Voluntary Specifications and Test Methods for Sealants

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z97.1 (2015) Safety Glazing Materials Used in Buildings - Safety Performance Specifications and Methods of Test

ASTM INTERNATIONAL (ASTM)

ASTM C509 (2006; R 2021) Standard Specification for Elastomeric Cellular Preformed Gasket and Sealing Material

ASTM C864 (2005; R 2015) Dense Elastomeric Compression Seal Gaskets, Setting Blocks, and Spacers

ASTM C920 (2018) Standard Specification for Elastomeric Joint Sealants

ASTM C1021 (2008; R 2014) Standard Practice for Laboratories Engaged in Testing of Building Sealants

ASTM C1036 (2021) Standard Specification for Flat Glass

ASTM C1048 (2018) Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass

ASTM C1087 (2016) Standard Test Method for Determining Compatibility of Liquid-Applied Sealants with Accessories Used in Structural Glazing Systems

ASTM C1172 (2019) Standard Specification for Laminated Architectural Flat Glass

ASTM C1281 (2016) Standard Specification for Preformed Tape Sealants for Glazing

Applications

ASTM C1376	(2015) Standard Specification for Pyrolytic and Vacuum Deposition Coatings on Flat Glass
ASTM D395	(2016; E 2017) Standard Test Methods for Rubber Property - Compression Set
ASTM D2287	(2019) Nonrigid Vinyl Chloride Polymer and Copolymer Molding and Extrusion Compounds
ASTM E1300	(2016) Standard Practice for Determining Load Resistance of Glass in Buildings
ASTM E2190	(2010) Standard Specification for Insulating Glass Unit Performance and Evaluation

GLASS ASSOCIATION OF NORTH AMERICA (GANA)

GANA Glazing Manual	(2008) Glazing Manual
GANA Sealant Manual	(2008) Sealant Manual
GANA Standards Manual	(2008) Engineering Standards Manual

INSULATING GLASS MANUFACTURERS ALLIANCE (IGMA)

IGMA TB-1200	(1983; R 2016) Guidelines for Insulating Glass Dimensional Tolerances
IGMA TB-3001	(2001) Guidelines for Sloped Glazing
IGMA TM-3000	(1990; R 2016) North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial & Residential Use

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 252	(2022) Standard Methods of Fire Tests of Door Assemblies
NFPA 257	(2022) Standard on Fire Test for Window and Glass Block Assemblies

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

16 CFR 1201	Safety Standard for Architectural Glazing Materials

1.2 SUBMITTALS

Government approval is required for submittals . Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Insulating Glass

Glazing Accessories

Sealants

SD-04 Samples

Insulating Glass

Glazing Compound

Glazing Tape

Sealing Tapes

SD-07 Certificates

Insulating Glass

SD-08 Manufacturer's Instructions

Setting and Sealing Materials

Glass Setting

SD-11 Closeout Submittals

Warranty for Insulated Glass Units

Warranty for Monolithic Reflective Glass

1.3 SYSTEM DESCRIPTION

Fabricate and install watertight and airtight glazing systems to withstand thermal movement and wind loading without glass breakage, gasket failure, deterioration of [glazing accessories](#), or defects in the work. Glazed panels must comply with the safety standards, in accordance with [ANSI Z97.1](#), and comply with indicated wind/snow loading in accordance with [ASTM E1300](#).

1.4 QUALITY CONTROL

Submit two [8 by 10 inch](#) samples of each of the following: insulating glass units.

1.5 DELIVERY, STORAGE, AND HANDLING

Deliver products to the site in unopened containers, labeled plainly with manufacturers' names and brands. Store glass and setting materials in safe, enclosed dry locations and do not unpack until needed for installation. Handle and install materials in a manner that will protect them from damage.

1.6 ENVIRONMENTAL REQUIREMENTS

Do not start glazing work until the outdoor temperature is above [40 degrees F](#) and rising, unless procedures recommended by the glass manufacturer and approved by the Contracting Officer are made to warm the glass and rabbet surfaces. Provide ventilation to prevent condensation of

moisture on glazing work during installation. Do not perform glazing work during damp or rainy weather.

1.7 WARRANTY

1.7.1 Warranty for Insulated Glass Units

Warranty insulating glass units against development of material obstruction to vision (such as dust, fogging, or film formation on the inner glass surfaces) caused by failure of the hermetic seal, other than through glass breakage, for a 10-year period following acceptance of the work. Provide new units for any units failing to comply with terms of this warranty within 45 working days after receipt of notice from the Government.

1.7.2 Monolithic Reflective Glass

Manufacturer must warrant the monolithic reflective glass to be free of peeling or deteriorating of coating for a period of 10 years after Date of Substantial Completion. Warranty must be signed by manufacturer.

PART 2 PRODUCTS

2.1 PRODUCT SUSTAINABILITY CRITERIA

2.2 GLASS

ASTM C1036, unless specified otherwise. In doors and sidelights, provide safety glazing material conforming to 16 CFR 1201.

2.2.1 Clear Glass

For interior glazing (i.e., pass and observation windows), 1/4 inch thick glass should be used.

2.2.2 Annealed Glass

Annealed glass must be Type I transparent flat type, Class 1 - clear, Quality q3 - glazing select, conforming to ASTM C1036.

2.2.3 Reflective Coating Vision Glass

ASTM C1376

2.2.4 Laminated Glass

ASTM C1172, Laminated glass fabricated from two nominal 1/8 inch pieces of Type I, Class 1, , Quality Q3, flat annealed clear glass conforming to ASTM C1036. Flat glass to be laminated together with a minimum of 0.030 inch inch thick, clear polyvinyl butyral laminate, conforming to requirements of 16 CFR 1201 and ASTM C1172. The total thickness of nominally 1/4 inches. Color to be clear.

2.2.5 Mirrors

2.2.5.1 Unframed Glass Mirrors

Glass for mirrors must be Type I transparent flat type, Class 1-clear, Glazing Quality q1 1/4 inch thick conforming to ASTM C1036. Glass must be

coated on one surface with silver coating, copper protective coating, and mirror backing paint. Silver coating must be highly adhesive pure silver coating of a thickness which must provide reflectivity of 83 percent or more of incident light when viewed through 1/4 inch thick glass, and must be free of pinholes or other defects. Copper protective coating must be pure bright reflective copper, homogeneous without sludge, pinholes or other defects, and must be of proper thickness to prevent "adhesion pull" by mirror backing paint. Mirror backing paint must consist of two coats of special scratch and abrasion-resistant paint, and must be baked in uniform thickness to provide a protection for silver and copper coatings which will permit normal cutting and edge fabrication.

2.2.6 Tempered Glass

ASTM C1048, Kind FT (fully tempered), Condition A (uncoated), Type I, Class 1 (transparent), Quality q3, thickness as indicated; conforming to ASTM C1048 and GANA Standards Manual. Tempering shall be produced by a horizontal type furnace, without tong marks. Color must be clear. Provide wherever safety glazing material is indicated or specified.

2.2.7 Fire/Safety Rated Glass

2.2.7.1 Fire Protection Rated Glass

Clear tempered and meet 16 CFR 1201 Category I (under 9 square feet) or II (over 9 square feet) impact safety standard. Glass to make 20 minute rating when tested in accordance with NFPA 257 and NFPA 252. Glass to be permanently labeled with appropriate markings.

2.3 INSULATING GLASS UNITS

Two panes of glass separated by a dehydrated airspace and hermetically sealed, conforming to ASTM E2190. IGU at exterior doors and windows are to include in inner pane with 1/4 inch nominal laminated glass and outer pane of 1/4 inch tempered glass. Submit performance and compliance documentation for each type of insulating glass.

Dimensional tolerances must be as specified in IGMA TB-1200. Spacer must be black, roll-formed, thermally broken aluminum, with bent or tightly welded or keyed and sealed joints to completely seal the spacer periphery and eliminate moisture and hydrocarbon vapor transmission into airspace through the corners. Primary seal must be compressed polyisobutylene and the secondary seal must be a specially formulated silicone.

2.4 SETTING AND SEALING MATERIALS

Provide as specified in the GANA Glazing Manual, IGMA TM-3000, IGMA TB-3001, and manufacturer's recommendations, unless specified otherwise herein. Do not use metal sash putty, nonskinning compounds, nonresilient preformed sealers, or impregnated preformed gaskets. Materials exposed to view and unpainted must be gray or neutral color. Sealant testing must be performed by a testing agency qualified according to ASTM C1021.

Submit glass manufacturer's recommendations for setting and sealing materials and for installation of each type of glazing material specified.

2.4.1 Putty and Glazing Compound

Provide glazing compound as recommended by manufacturer for face-glazing

metal sash. Putty must be linseed oil type. Do not use putty and glazing compounds with insulating glass or laminated glass.

2.4.2 Glazing Compound

Use for face glazing metal sash. Do not use with insulating glass units or laminated glass.

2.4.3 Sealants

Provide elastomeric sealants.

2.4.3.1 Elastomeric Sealant

ASTM C920, Type S, Grade NS, Class 12.5, Use G. Use for channel or stop glazing wood and metal sash. **Sealants** must be chemically compatible with setting blocks, edge blocks, and sealing tapes, with sealants used in manufacture of insulating glass units. Color of sealant must be white.

2.4.4 Glazing Tapes

2.4.4.1 Back-Bedding Mastic Glazing Tapes

Preformed, butyl-based, 100 percent solids elastomeric tape; nonstaining and nonmigrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by tape and glass manufacturers for application indicated; and complying with **ASTM C1281** and **AAMA 800** for products indicated below:

- a. AAMA 804.3 tape, where indicated.
- b. AAMA 806.3 tape, for glazing applications in which tape is subject to continuous pressure.
- c. AAMA 807.3 tape, for glazing applications in which tape is not subject to continuous pressure.

2.4.4.2 Expanded Cellular Glazing Tapes

Closed-cell, PVC foam tapes; factory coated with adhesive on both surfaces; and complying with **AAMA 800** for the following types:

- a. AAMA 810.1, Type 1, for glazing applications in which tape acts as the primary sealant.
- b. AAMA 810.1, Type 2, for glazing applications in which tape is used in combination with a full bead of liquid sealant.

2.4.5 Sealing Tapes

Preformed, semisolid, PVC-based material of proper size and compressibility for the particular condition, complying with **ASTM D2287**. Use only where glazing rabbet is designed for tape and **tape** is recommended by the glass or sealant manufacturer. Provide spacer shims for use with compressible tapes. Tapes must be chemically compatible with the product being set.

2.4.6 Setting Blocks and Edge Blocks

Closed-cell neoprene setting blocks must be dense extruded type conforming to [ASTM C509](#) and [ASTM D395](#), Method B, Shore A durometer between 70 and 90. Edge blocking must be Shore A durometer of 50 (plus or minus 5). Provide silicone setting blocks when blocks are in contact with silicone sealant. Profiles, lengths and locations must be as required and recommended in writing by glass manufacturer. Block color must be black.

2.4.7 Glazing Gaskets

Glazing gaskets must be extruded with continuous integral locking projection designed to engage into metal glass holding members to provide a watertight seal during dynamic loading, building movements and thermal movements. Glazing gaskets for a single glazed opening must be continuous one-piece units with factory-fabricated injection-molded corners free of flashing and burrs. Glazing gaskets must be in lengths or units recommended by manufacturer to ensure against pull-back at corners. Provide glazing gasket profiles as recommended by the manufacturer for the intended application.

2.4.7.1 Fixed Glazing Gaskets

Fixed glazing gaskets must be closed-cell (sponge) smooth extruded compression gaskets of cured elastomeric virgin neoprene compounds conforming to [ASTM C509](#), Type 2, Option 1.

2.4.7.2 Wedge Glazing Gaskets

Wedge glazing gaskets must be high-quality extrusions of cured elastomeric virgin neoprene compounds, ozone resistant, conforming to [ASTM C864](#), Option 1, Shore A durometer between 65 and 75.

2.4.7.3 Aluminum Framing Glazing Gaskets

Glazing gaskets for aluminum framing must be permanent, elastic, non-shrinking, non-migrating, watertight and weathertight.

2.4.8 Accessories

Provide as required for a complete installation, including glazing points, clips, shims, angles, beads, and spacer strips. Provide noncorroding metal accessories. Provide primer-sealers and cleaners as recommended by the glass and sealant manufacturers. Use [ASTM C1087](#) to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of glazing sealants to surface.

2.5 MIRROR ACCESSORIES

2.5.1 Mirror Frames

Provide mirrors with mirror frames (J-mold channels) [along the top and bottom edges](#); fabricate [frames](#) of one-piece roll-formed Type 304 stainless steel with No. 4 brushed satin finish and concealed fasteners which will keep mirrors snug to wall. Frames must be [1-1/4 by 1/4 by 1/4 inch](#) continuous at top and bottom of mirrors. Concealed fasteners of type to suit wall construction material must be provided with mirror frames.

PART 3 EXECUTION

Any materials that show visual evidence of biological growth due to the presence of moisture must not be installed on the building project.

3.1 PREPARATION

Preparation, unless otherwise specified or approved, must conform to applicable recommendations in the [GANA Glazing Manual](#), [GANA Sealant Manual](#), [IGMA TB-3001](#), [IGMA TM-3000](#), and manufacturer's recommendations. Determine the sizes to provide the required edge clearances by measuring the actual opening to receive the glass. Grind smooth in the shop glass edges that will be exposed in finish work. Leave labels in place until the installation is approved, except remove applied labels on heat-absorbing glass and on insulating glass units as soon as glass is installed. Securely fix movable items or keep in a closed and locked position until glazing compound has thoroughly set.

3.2 GLASS SETTING

Shop glaze or field glaze items to be glazed using glass of the quality and thickness specified or indicated. Glazing, unless otherwise specified or approved, must conform to applicable recommendations in the [GANA Glazing Manual](#), [GANA Sealant Manual](#), [IGMA TB-3001](#), [IGMA TM-3000](#), and manufacturer's recommendations. Aluminum windows, wood doors, and wood windows may be glazed in conformance with one of the glazing methods described in the standards under which they are produced, except that face puttying with no bedding will not be permitted. Handle and install glazing materials in accordance with manufacturer's instructions. Use beads or stops which are furnished with items to be glazed to secure the glass in place. Verify products are properly installed, connected, and adjusted.

3.2.1 Sheet Glass

Cut and set with the visible lines or waves horizontal.

3.2.2 Insulating Glass Units

Do not grind, nip, or cut edges or corners of units after the units have left the factory. Springing, forcing, or twisting of units during setting will not be permitted. Handle units so as not to strike frames or other objects. Installation must conform to applicable recommendations of [IGMA TB-3001](#) and [IGMA TM-3000](#).

3.2.3 Installation of Laminated Glass

Sashes which are to receive laminated glass must be weeped to the outside to allow water drainage into the channel.

3.3 CLEANING

Clean glass surfaces and remove labels, paint spots, putty, and other defacement as required to prevent staining. Glass must be clean at the time the work is accepted.

3.4 PROTECTION

Protect glass work immediately after installation. Identify glazed

openings with suitable warning tapes, cloth or paper flags, attached with non-staining adhesives. Protect reflective glass with a protective material to eliminate any contamination of the reflective coating. Place protective material far enough away from the coated glass to allow air to circulate to reduce heat buildup and moisture accumulation on the glass. Upon removal, separate protective materials for reuse or recycling. Remove and replace glass units which are broken, chipped, cracked, abraded, or otherwise damaged during construction activities with new units.

-- End of Section --

SECTION 08 91 00

METAL WALL LOUVERS
08/20

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL, INC. (AMCA)

AMCA 500-L (2015) Laboratory Methods of Testing
Louvers for Rating

AMCA 511 (2010; R 2016) Certified Ratings Program
for Air Control Devices

AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION (AAMA)

AAMA 2605 (2020) Voluntary Specification,
Performance Requirements and Test
Procedures for Superior Performing Organic
Coatings on Aluminum Extrusions and Panels

ASTM INTERNATIONAL (ASTM)

ASTM B209 (2014) Standard Specification for Aluminum
and Aluminum-Alloy Sheet and Plate

ASTM B221 (2021) Standard Specification for Aluminum
and Aluminum-Alloy Extruded Bars, Rods,
Wire, Profiles, and Tubes

1.2 SUBMITTALS

Government approval is required for submittals . Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Wall Louvers

SD-03 Product Data

Metal Wall Louvers

SD-04 Samples

Wall Louver Samples

1.3 DELIVERY, STORAGE, AND PROTECTION

Deliver materials to the site in an undamaged condition. Carefully store materials off the ground to provide proper ventilation, drainage, and

protection against dampness. Louvers must be free from nicks, scratches, and blemishes. Replace defective or damaged materials with new.

1.4 DETAIL DRAWINGS

Show all information necessary for fabrication and installation of [wall louvers](#). Indicate materials, sizes, thicknesses, fastenings, and profiles.

1.5 COLOR SAMPLES

Colors of finishes for [wall louver samples](#) must closely approximate colors indicated. Where color is not indicated, submit the manufacturer's standard colors to the Contracting Officer for selection.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Aluminum Sheet

[ASTM B209](#), alloy 3003 or 5005 with temper as required for forming.

2.1.2 Extruded Aluminum

[ASTM B221](#), alloy 6063-T5 or -T52.

2.2 METAL WALL LOUVERS

Weather resistant type, with bird screens and made to withstand a wind load of not less than [20 pounds per square foot](#). Wall louvers must bear the AMCA certified ratings program seal for air performance and water penetration in accordance with [AMCA 500-L](#) and [AMCA 511](#). The rating must show a water penetration of [0.20 or less ounce per square foot](#) of free area at a free velocity of [800 feet](#) per minute.

2.2.1 Extruded Aluminum Louvers

Fabricated of extruded 6063-T5 or -T52 aluminum with a wall thickness of not less than [0.081 inch](#).

2.2.2 Formed Metal Louvers

Formed of aluminum sheet not less than [0.08 inch](#) thick.

2.2.3 Mullions and Mullion Covers

Same material and finish as louvers. Provide mullions for all louvers more than [4 feet](#) in width at not more than [4 feet](#) on centers. Provide mullion covers on both faces of joints between louvers.

2.2.4 Screens and Frames

For aluminum louvers, provide [inside mounted 4 x 4 mesh screen](#). Mount screens in removable, rewirable frames of same material and finish as the louvers.

2.3 FASTENERS AND ACCESSORIES

Provide stainless steel screws and fasteners for aluminum louvers.

Provide other accessories as required for complete and proper installation.

2.4 FINISHES

2.4.1 Aluminum

Exposed aluminum surfaces must be factory finished with an organic coating.
Color as selected from manufacturer's standard colors.

2.4.1.1 Organic Coating

Clean and prime exposed aluminum surfaces. Provide a superior performance finish in accordance with AAMA 2605 with total dry film thickness of not less than 1.2 mil.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Wall Louvers

Install using stops or moldings, flanges, strap anchors, or jamb fasteners as appropriate for the wall construction and in accordance with manufacturer's recommendations.

3.1.2 Screens and Frames

Attach frames to louvers with screws or bolts.

3.2 PROTECTION FROM CONTACT OF DISSIMILAR MATERIALS

3.2.1 Aluminum

Where aluminum contacts metal other than zinc, paint the dissimilar metal with a primer and two coats of aluminum paint.

3.2.2 Metal

Paint metal in contact with mortar, concrete, or other masonry materials with alkali-resistant coatings such as heavy-bodied bituminous paint.

3.2.3 Wood

Paint wood or other absorptive materials that may become repeatedly wet and in contact with metal with two coats of aluminum paint or a coat of heavy-bodied bituminous paint.

-- End of Section --

SECTION 09 22 00

SUPPORTS FOR PLASTER AND GYPSUM BOARD
02/10, CHG 2: 08/18

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM A463/A463M	(2022) Standard Specification for Steel Sheet, Aluminum-Coated, by the Hot-Dip Process
ASTM A653/A653M	(2022) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM C645	(2014; E 2015) Nonstructural Steel Framing Members
ASTM C754	(2020) Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products

1.2 SUBMITTALS

Government approval is required for submittals . Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Metal Support Systems

Submit for the erection of metal framing, furring,. Indicate materials, sizes, thicknesses, and fastenings.

SD-03 Product Data

Metal Support Systems

Recycled Content for Metal Support Systems

1.3 DELIVERY, STORAGE, AND HANDLING

Deliver materials to the job site and store in ventilated dry locations permitting easy access for inspection and handling. If materials are stored outdoors, stack materials off the ground, supported on a level platform, and fully protected from the weather. Handle materials carefully to prevent damage. Remove damaged items and provide new items.

PART 2 PRODUCTS

2.1 MATERIALS

Provide steel materials for metal support systems with galvanized coating ASTM A653/A653M, G-60; aluminum coating ASTM A463/A463M, T1-25; or a 55-percent aluminum-zinc coating.

Provide metal support systems containing a minimum of 20 percent recycled content. Provide data identifying percentage of recycled content for metal support systems.

2.1.1 Materials for Attachment of Gypsum Wallboard

2.1.1.1 Non-load Bearing Wall Framing and Furring

ASTM C645, but not thinner than 0.0329 inch thickness regardless of the ASTM certified third party testing statement for equivalent thicknesses. Provide 18 ga or heavier (43 mils) where noted.

- A. Floor Track: Channel shape, same ga. as studs, with 1.25 inch legs, of width to nest with studs.
- B. Ceiling Track: Same as floor track. One piece lengths up to 10'-0" Slot tracks together to allow for movement.
- C. Studs: Punched box channel shape with 1.25 inch leg faces, 3-5/8 inch wide (unless noted otherwise), full unspliced lengths.
- D. Bridging and Stiffeners: Stiffeners shall be long lengths of 1.5 inches - 0.5 plf CR channels run thru stud cutouts and wedged in place with legs down.

2.1.1.2 Furring on Masonry Walls:

Not lighter than 20 gage galvanized steel, provide furring (3-5/8 inch studs) on 16 inch centers elsewhere. Place so that all edges of board will be on bearing. Secure furring channels with concrete nails driven through alternate edges 24 inch oc.

2.1.1.3 Mechanical Chases:

Where mechanical work or other condition requires, increase stud width to 6 inches; or employ double studs assembled back-to-back in offset fashion so as to produce required wall cavity thickness. Secure such double studs with screws on 24 inch centers.

At duct and plenum shafts where floor or ceiling assembly is penetrated, provide the shaft-wall system completely around the shaft.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Systems for Attachment of Gypsum Wallboard

3.1.1.1 Non-load Bearing Wall Framing and Furring

ASTM C754, except as indicated otherwise.

- A. Floor Track: Ram-set to floor on 2-foot centers, within 4 inches of ends of each piece, with not less than 2 anchors per piece. Employ full length pieces, with no piece shorter than 24 inches. Where sound wall is noted, bed track in a serpentine bead of acoustical sealant.
- B. Ceiling Track: Where splices are unavoidable butt-join members with a 16 inch long nesting stud section utilized as a splice piece; secure in place with 2 screws in each leg on each side of joint. Secure at all intersections with overlapping webb/shear type screw connections. Attach to overhead structure.
- C. Studs: Space not more than 16 inches oc except where noted otherwise, and set to provide bearing for vertical edges of finish material. Provide heavy gauge studs (double where shown) where heavy equipment is to be mounted (such as plumbing fixture, shelf, etc.), where lead lath occurs, and where otherwise noted. Heavy studs shall be full height, with double studs assembled back-to-back with screws 24 inches oc staggered.

Secure every stud to top and bottom runner tracks with screws or special tools of type as recommended by stud manufacturer (unless welding is noted). At intersections, terminals and jamps, secure studs with at least one screw through each leg into the track flange (4 screws per stud).

- D. Bridging and Stiffeners: Provide one stiffener row in all walls near center but located to avoid conflict with electrical devices (two rows at third points in walls over 10 feet high). Provide an additional row near top of partitions where top plate cannot run continuous. Extend stiffeners well into backs of hollow metal frames.

Where single faced wall occurs (such as furred out spaces), provide horizontal bridging on 48" centers maximum spacing and consisting of a typical stud section surface applied on the back side of the wall. Secure with 2 screws per stud intersection.

3.2 ERECTION TOLERANCES

Provide framing members which will be covered by finish materials such as wallboard, plaster, or ceramic tile set in a mortar setting bed, within the following limits:

- a. Layout of walls and partitions: 1/4 inch from intended position;
- b. Plates and runners: 1/4 inch in 8 feet from a straight line;
- c. Studs: 1/4 inch in 8 feet out of plumb, not cumulative; and
- d. Face of framing members: 1/4 inch in 8 feet from a true plane.

Provide framing members which will be covered by ceramic tile set in dry-set mortar, latex-portland cement mortar, or organic adhesive within the following limits:

- a. Layout of walls and partitions: 1/4 inch from intended position;
- b. Plates and runners: 1/8 inch in 8 feet from a straight line;

- c. Studs: 1/8 inch in 8 feet out of plumb, not cumulative; and
- d. Face of framing members: 1/8 inch in 8 feet from a true plane.

-- End of Section --

SECTION 09 24 23

CEMENT STUCCO
08/17, CHG 2: 11/18

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM A1064/A1064M	(2022) Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
ASTM C150/C150M	(2022) Standard Specification for Portland Cement
ASTM C206	(2014; R 2022) Standard Specification for Finishing Hydrated Lime
ASTM C841	(2003; R 2013) Installation of Interior Lathing and Furring
ASTM C847	(2014a) Standard Specification for Metal Lath
ASTM C897	(2015; R 2020) Aggregate for Job-Mixed Portland Cement-Based Plasters
ASTM C926	(2022b) Standard Specification for Application of Portland Cement-Based Plaster
ASTM C933	(2014) Welded Wire Lath
ASTM C1032	(2014) Standard Specification for Woven Wire Plaster Base
ASTM C1063	(2022) Standard Specification for Installation of Lathing and Furring to Receive Interior and Exterior Portland Cement-Based Plaster

1.2 SUBMITTALS

Government approval is required for submittals. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Lath

SD-03 Product Data

Proportions and Mixing

Acrylic Stucco System

Weather Barrier

SD-04 Samples

Colored Stucco Finish Coat

Sample Panel

SD-07 Certificates

Recycled Content For Metal Lath

1.3 QUALITY ASSURANCE

Submit a **SAMPLE PANEL** as follows: A sample panel of **acrylic stucco system**, constructed at the jobsite, and located as directed, to demonstrate installation procedures, texture and color **to match existing exterior wall surfaces**, prior to proceeding with any stucco work; panel size must be a minimum of **4 feet wide x 8 feet** high; containing each type accessory proposed for use and constructed in the vertical position. Sample panel must have exposed reinforcement at the edges. Each phase of installation such as framing, scratch coat, brown coat, finish coat and curing procedures must be demonstrated in the construction of the panel. Submit one **12 inch** square of reinforcement and one **12 inch** length of each accessory proposed for use, prior to constructing the sample panel.

1.4 DELIVERY, STORAGE, AND HANDLING

Deliver packaged materials to the site in the original packages and containers with labels intact and seals unbroken. Keep cementitious materials dry and stored off the ground, under cover and away from damp surfaces until ready to be used. Aggregate must be covered to prevent the absorption or loss of moisture.

1.5 ENVIRONMENTAL REQUIREMENTS

Do not apply stucco when the ambient temperature is **40 degrees F** or lower, or when a drop in temperature below **40 degrees F** is expected within 48 hours after application.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

2.1.1 Acrylic Stucco System (DEFS)

Three-coat Stucco System; water resistive barrier sheet, wire fabric or metal lath, fiber reinforced scratch and brown coat (3/4 in (19 mm)) and either an acrylic based finish coat.

2.1.2 Stucco Repair

Patching of damaged or deteriorated stucco on the existing exterior

building surfaces. Where areas are to be patched , remove existing damaged or deteriorated material back to the sound substrate, then proceed to patch with proper materials and components.

2.2 PORTLAND CEMENT

Portland cement must conform to [ASTM C150/C150M](#), gray Portland cement Type I.

2.3 Scratch & Brown Concentrate:

Mixture of portland cement and 100 percent acrylic emulsion additive mixed with clean, cool, potable water, and ASTM C897 or ASTM C144 sand added in the field.

2.4 COLORED STUCCO FINISH COAT

Colored stucco finish coat must be a mill mixed product using white Portland cement and requiring only the addition of and mixing with water for application. Color shall match the existing exterior stucco finish in color and texture. Submit samples including both a fabricated portion of unit of work and color samples.

2.5 Acrylic Finish Coat (DEFS)

A 100 percent acrylic polymer-based elastomeric, textured, factory-mixed coating. Finish shall have integral color and finish to match the existing exterior stucco wall finish.

2.6 LIME

Lime must conform to [ASTM C206](#), Type S.

2.7 SAND

Sand aggregate for job-mixed base coat and job-mixed finish coat stucco must conform to [ASTM C897](#).

2.8 ACCESSORIES

Accessories must be roll formed galvanized steel,, except that cornerite and striplath must be formed from steel sheets with manufacturer's standard galvanized coating. Welded wire corner reinforcements must be zinc coated, galvanized 17 gauge steel wire conforming to [ASTM A1064/A1064M](#). Furring must include hangers, bolts, inserts, clips, fastenings, and attachments of number, size, and design to develop the full strength of the members.

2.9 Weather Barrier:

Apply liquid air barrier membrane with joints treated over sheathing. Then apply one (1) layer asphalt saturated felt complying with [ASTM D226/D226M](#) Type I.

2.10 METAL LATH

Metal lath must conform to [ASTM C847](#), types and weights in accordance with the various spacing shown in [ASTM C841](#). Woven wire lath must be a maximum 1-1/2 x 1-1/2 inch mesh wire of not less than 0.0540 inch nominal diameter

and must conform to [ASTM C1032](#). Welded wire lath must conform to [ASTM C933](#), with openings not to exceed [2 x 2 inches](#). Expanded metal or wire lath must be fabricated in a manner to provide not less than [1/4 inch](#) keying between wire and paper backing and keying must be obtained by a uniform series of slots in a perforated face paper woven between the wires.

Provide Metal Lath containing a minimum of 20 percent recycled content, as calculated by the sum of the percentage of post-consumer and [1/2](#) the percentage of pre-consumer recycled steel content. Provide data identifying percentage of [recycled content for metal lath](#).

2.11 WATER

Provide clean, fresh, potable water, free from amounts of oils, acids, alkalis and organic matter that would be injurious to the stucco.

PART 3 EXECUTION

3.1 INSTALLATION

Do not install building construction materials that show visual evidence of biological growth.

3.2 FRAMING

Framing must be installed as indicated.

3.3 CONTROL JOINTS

Locate control joints so that unbroken areas of stucco do not exceed [144 square feet](#) with no dimension between control joints greater than [18 ft](#). Install prefabricated control joint members prior to the application of the stucco. Clear control joints of all stucco within the control area after stucco application and prior to final stucco set.

3.4 LATH

Install lath in accordance with [ASTM C841](#) or [ASTM C1063](#) except as otherwise specified. Metal and wire lath must be applied straight, without buckles and with joints staggered. End laps of metal lath must be not less than [1 inch](#). When paper-backed lath is used, the paper must be split from the lath at all lap areas to provide a paper to paper and lath to lath lap. Horizontal joints must be shiplapped. Lath must be interrupted at all control joints. Submit drawings showing details of construction for reinforcement, furring, and grounds; including manufacturer's installation instructions for stucco materials, and locations where each mix and coating thickness will be used.

3.4.1 On Concrete and Masonry

Fasten lath every [8 inches](#) vertically and every [16 inches](#) horizontally. Where wood supports adjoin masonry or concrete in the same direction, provide casing bead, control joints, or reinforcement as indicated.

3.4.2 Special Shapes, Profiles, and Contours

Special shapes, profiles, and contours must be formed with wood, metal or aluminum furring and reinforcing.

3.5 PREPARATION OF SURFACES

Preparation of surfaces for application of stucco to solid bases such as masonry or concrete must conform to the applicable requirements of **ASTM C926**.

3.6 PROPORTIONS AND MIXING

Proportions and mixing for job-mixed base coat and finish coat must conform to the applicable requirements of **ASTM C926**. Mixing of mill-mixed finish coat must be in accordance with the manufacturer's directions. Submit detailed description of the proposed job-mix proportions for base and finish coats; including identification of thickness of coats.

3.7 EXISTING STUCCO REPAIR

3.7.1 Application:

Dampen masonry surfaces before proceeding. Apply with trowel using sufficient pressure to fill raked joints in masonry or to shove through and completely embed reinforcing lath. Scratch first coat in two directions. Uniformly dampen each coat before applying next coat. Rod and float second coat, leaving surface rough.

Screed at all angles, arrises, corners and every 8'-0" on surfaces. Place screeds to true ground. All corners to be plumb, true and sharp. Rod finish coats with a straightedge not less than 10'-0" long. Keep a straight edge on the job for use by the Architect in checking the work. Finish surface shall not vary more than 1/4 inch from true plane; with less variation where necessary to juncture with other work.

Except as noted, score lines, etc. shall return into sills, jambs, soffits, etc. as required to complete the joint pattern and to provide crack control.

3.7.2 Base Coats:

Mix scratch and brown coat as one part Portland cement, to 3 to 5 parts sand by volume. Add hydrated lime as a plastizer in volume from 10 percent to 20 percent of the cement. Apply scratch coat in full 1/2 inch layer with sufficient pressure to form bond and cross scratch. Damp cure for 48 hours with fine water spray.

Apply brown coat over dampened scratch coat as 3/8 inch thick coat, level up with straight edge and broom surface. Damp cure at least 48 hours.

3.7.3 Finish Coat:

Cure brown coat for 5 days then damp spray surface and apply finish coat of factory mixed Portland cement stucco finish in 3/8 inch thick coat for 1 inch total thickness (as measured from back of lath). Work to fine sand finish to match adjacent wall surfaces and damp cure for 48 hours.

3.8 ACRYLIC STUCCO APPLICATION

Stucco must be applied in three coats to a **total** thickness of not less than **1 inch** as measured from the back plane of metal reinforcement, exclusive of ribs or dimples or from the face of solid backing or support, with or without metal reinforcement, to the finished stucco surface, including

moderate texture variations. Stucco application must conform to the applicable requirements of [ASTM C926](#) and the following:

3.8.1 Workmanship

Items or features of the work in connection with or adjoining the stucco must be in place, plumb, straight, and true prior to beginning the stucco work. Metal and wire lath, where required, must be in place and positioned to provide a good key at back of lath. Masonry surfaces to receive stucco must be evenly dampened immediately prior to application of stucco. Each stucco coat must be applied continuously in one general direction, without allowing mortar to dry at edges. Where it is impossible to work the full dimension of a wall surface in a continuous operation, jointing must be made at a break, opening, or other natural division of the surface. Edges to be joined must be dampened slightly to produce a smooth confluence. Exterior corners of stucco must be slightly rounded. Stucco on soffit surfaces must be pitched forward to form a drip.

3.8.2 Scratch Coat

Apply scratch coat not less than [3/8 inch](#) thick under sufficient pressure to form good keys and to completely embed the reinforcement. Before the scratch coat has set, it must be lightly scratched in one direction and vertical surfaces must be scratched in the horizontal direction only. The scratch coat must be fog cured for a minimum of 72 hours.

3.8.3 Brown Coat

Evenly dampen the scratch coat to obtain uniform suction before the brown coat is applied. There must be no visible water on the surface when the brown coat is applied. [Apply brown coat to a minimum thickness of 3/8 in \(9.5 mm\), using sufficient trowel pressure to key stucco into scratch coat, and bring to a plumb, true, even plane with rod or straightedge.](#) When set sufficiently, the brown coat must be uniformly floated with a dry float to promote densification of the coat and to provide a surface receptive to bonding of the finish coat. Brown coat must be fog cured for a minimum of 72 hours.

3.8.4 Finish Coat

Dampen surfaces of the brown coat not more than 1 hour before the finish coat is to be applied to a uniform wetness with no free-standing water on the surface. The finish coat must have a [textured finish to match the existing stucco wall finish.](#) [Air dry acrylic based finish coat per manufacturer's instructions.](#) Take care to prevent staining.

3.8.5 Surface Tolerance

When a [10 foot](#) straightedge is placed at any location on the finished surface of the stucco, excluding rough-textured finish, the surface must not vary more than [1/8 inch](#) from the straightedge.

3.9 CURING AND PROTECTION

Perform fog curing [on stucco repairs](#) by applying a fine mist of water to the stucco. Exercise care during fog curing to avoid erosion damage of the stucco surfaces. Do not use a solid stream of water. Fog not less than three times daily. Protect the stucco from the direct rays of the sun during severe drying conditions using canvas, cloth or other approved

sheet material.

Provide protection of installed finish from dust, dirt, precipitation, freezing, and continuous high humidity until fully dry.

Clean exposed surfaces using materials and methods recommended by the manufacturer of the material or product being cleaned. Remove and replace work that cannot be cleaned to the satisfaction of the Architect.

3.10 PATCHING AND POINTING

Replace or patch loose, cracked, damaged or defective work as directed. Patching must match existing work in texture and color and must be finished flush.

-- End of Section --

SECTION 09 29 00

GYPSUM BOARD
08/16, CHG 4: 02/20

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM C475/C475M	(2017; R 2022) Standard Specification for Joint Compound and Joint Tape for Finishing Gypsum Board
ASTM C840	(2020) Standard Specification for Application and Finishing of Gypsum Board
ASTM C954	(2022) Standard Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs from 0.033 in. (0.84 mm) to 0.112 in. (2.84 mm) in Thickness
ASTM C1002	(2022) Standard Specification for Steel Self-Piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs
ASTM C1047	(2019) Standard Specification for Accessories for Gypsum Wallboard and Gypsum Veneer Base
ASTM C1177/C1177M	(2017) Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing
ASTM C1178/C1178M	(2013) Standard Specification for Glass Mat Water-Resistant Gypsum Backing Panel
ASTM C1396/C1396M	(2017) Standard Specification for Gypsum Board
ASTM D226/D226M	(2017) Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing
ASTM D412	(2016) Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension
ASTM D624	(2000; R 2020) Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers

ASTM D1149 (2007; R 2012) Standard Test Method for Rubber Deterioration - Surface Ozone Cracking in a Chamber

ASTM D3273 (2016) Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber

CALIFORNIA DEPARTMENT OF PUBLIC HEALTH (CDPH)

CDPH SECTION 01350 (2010; Version 1.1) Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources using Environmental Chambers

FM GLOBAL (FM)

FM APP GUIDE (updated on-line) Approval Guide
<http://www.approvalguide.com/>

GYPSUM ASSOCIATION (GA)

GA 214 (2010) Recommended Levels of Gypsum Board Finish

GA 216 (2016) Application and Finishing of Gypsum Panel Products

GA 253 (2012) Application of Gypsum Sheathing

UNDERWRITERS LABORATORIES (UL)

UL 2818 (2013) GREENGUARD Certification Program For Chemical Emissions For Building Materials, Finishes And Furnishings

UL Fire Resistance (2014) Fire Resistance Directory

1.2 SUBMITTALS

Government approval is required for submittals. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Glass Mat Water-Resistant Gypsum Tile Backing Board

Glass Mat Covered or Reinforced Gypsum Sheathing

Glass Mat Covered or Reinforced Gypsum Sheathing Sealant

Accessories

Submit for each type of gypsum board and for cementitious backer units.

Gypsum Board

VOC Content of Joint Compound

SD-06 Test Reports

ASTM E90 Factory Test Report

SD-07 Certificates

Asbestos Free Materials;

Certify that gypsum board types, gypsum backing board types, cementitious backer units, and joint treating materials do not contain asbestos.

Indoor Air Quality for Gypsum Board; S

1.3 CERTIFICATIONS

1.3.1 Indoor Air Quality Certifications

Submit required indoor air quality certifications in one submittal package.

1.3.1.1 Adhesives and Sealants

Provide products certified to meet indoor air quality requirements by **UL 2818** (Greenguard) Gold, SCS Global Services Indoor Advantage Gold or provide certification or validation by other third-party program that products meet the requirements of this Section. Provide current product certification documentation from certification body. When product does not have certification, provide validation that product meets the indoor air quality product requirements cited herein.

1.4 DELIVERY, STORAGE, AND HANDLING

1.4.1 Delivery

Deliver materials in the original packages, containers, or bundles with each bearing the brand name, applicable standard designation, and name of manufacturer, or supplier.

1.4.2 Storage

Keep materials dry by storing inside a sheltered building. Where necessary to store gypsum board and cementitious backer units outside, store off the ground, properly supported on a level platform, and protected from direct exposure to rain, snow, sunlight, and other extreme weather conditions. Provide adequate ventilation to prevent condensation. Store per manufacturer's recommendations for allowable temperature and humidity range. Do not store panels near materials that may offgas or emit harmful fumes, such as kerosene heaters, fresh paint, or adhesives. Do not use materials that have visible moisture or biological growth.

1.4.3 Handling

Neatly stack gypsum board and cementitious backer units flat to prevent sagging or damage to the edges, ends, and surfaces.

1.5 QUALIFICATIONS

Furnish type of gypsum board work specialized by the installer with a minimum of 3 years of documented successful experience.

1.6 ENVIRONMENTAL REQUIREMENTS

Do not expose the gypsum board to excessive sunlight prior to gypsum board application. Maintain a continuous uniform temperature of not less than 50 degrees F and not more than 80 degrees F for at least one week prior to the application of gypsum board work, while the gypsum board application is being done, and for at least one week after the gypsum board is set. Shield air supply and distribution devices to prevent any uneven flow of air across the plastered surfaces. Provide ventilation to exhaust moist air to the outside during gypsum board application, set, and until gypsum board jointing is dry. In glazed areas, keep windows open top and bottom or side to side 3 to 4 inches. Reduce openings in cold weather to prevent freezing of joint compound when applied. For enclosed areas lacking natural ventilation, provide temporary mechanical means for ventilation. In unglazed areas subjected to hot, dry winds or temperature differentials from day to night of 20 degrees F or more, screen openings with cheesecloth or similar materials. Avoid rapid drying. During periods of low indoor humidity, provide minimum air circulation following gypsum boarding and until gypsum board jointing complete and is dry.

1.7 FIRE RESISTIVE CONSTRUCTION

Comply with specified fire-rated assemblies for design numbers indicated per UL Fire Resistance or FM APP GUIDE.

PART 2 PRODUCTS

2.1 MATERIALS

Conform to specifications, standards and requirements specified. Provide gypsum board types, gypsum backing board types, cementitious backing units, and joint treating materials manufactured from asbestos free materials only.

2.1.1 Gypsum Board

ASTM C1396/C1396M. Provide gypsum wall board and panels meeting the emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type). Provide certification or validation of indoor air quality for gypsum board.

2.1.1.1 Regular

48 inch wide, 5/8 inch thick, tapered edges.

2.1.1.2 Mold Resistant / Anti-Microbial Gypsum

ASTM D3273. 48 inch wide, 5/8 inch thick, tapered edges.

2.1.2 Glass Mat Water-Resistant Gypsum Tile Backing Board

ASTM C1178/C1178M

2.1.2.1 Regular

48 inch wide, 5/8 inch thick, square edges.

2.1.3 Glass Mat Covered or Reinforced Gypsum Sheathing

Exceeds physical properties of ASTM C1396/C1396M and ASTM C1177/C1177M. Provide 5/8 inch, gypsum sheathing. Provide gypsum board of with a noncombustible water-resistant core, with glass mat surfaces embedded to the gypsum core or reinforcing embedded throughout the gypsum core. Warrant gypsum sheathing board for at least twelve months against delamination due to direct weather exposure. Provide continuous, asphalt impregnated, building felt to cover exterior face of sheathing. Seal all joints, seams, and penetrations with compatible sealant.

2.1.3.1 Glass Mat Covered or Reinforced Gypsum Sheathing Sealant

Provide sealant compatible with glass mat covered or reinforced gypsum sheathing, rubber washers for masonry veneer anchors, and other associated cavity wall components such as anchors and through wall flashing. Provide sealants for glass mat covered or reinforced gypsum sheathing board edge seams and veneer anchor penetrations recommended by the glass mat covered or reinforced gypsum sheathing manufacturer and have the following performance requirements:

- a. ASTM D412: Tensile Strength, 80 psi
- b. ASTM D412: Ultimate Tensile Strength (maximum elongation), 170 psi
- c. ASTM D624: Tear Strength, dieB, 27 ppi
- d. ASTM D1149: Joint Movement Capability after 14 Days cure, plus or minus 50 percent.

2.1.4 Joint Treatment Materials

ASTM C475/C475M. Product must be low emitting VOC types with VOC limits not exceeding 50 g/L. Provide data identifying VOC content of joint compound. Use all purpose joint and texturing compound containing inert fillers and natural binders, including lime compound. Pre-mixed compounds must be free of antifreeze, vinyl adhesives, preservatives, biocides and other slow releasing compounds.

2.1.4.1 Embedding Compound

Specifically formulated and manufactured for use in embedding tape at gypsum board joints and compatible with tape, substrate and fasteners.

2.1.4.2 Finishing or Topping Compound

Specifically formulated and manufactured for use as a finishing compound.

2.1.4.3 All-Purpose Compound

Specifically formulated and manufactured to serve as both a taping and a finishing compound and compatible with tape, substrate and fasteners.

2.1.4.4 Setting or Hardening Type Compound

Specifically formulated and manufactured for use with fiber glass mesh tape.

2.1.4.5 Joint Tape

Use cross-laminated, tapered edge, reinforced paper, or fiber glass mesh tape recommended by the manufacturer.

2.1.5 Fasteners

2.1.5.1 Screws

ASTM C1002, Type "G", Type "S" or Type "W" steel drill screws for fastening gypsum board to gypsum board, wood framing members and steel framing members less than 0.033 inch thick. ASTM C954 steel drill screws for fastening gypsum board to steel framing members 0.033 to 0.112 inch thick. Provide cementitious backer unit screws with a polymer coating.

2.1.6 Accessories

ASTM C1047. Fabricate from corrosion protected steel designed for intended use. Accessories manufactured with paper flanges are not acceptable. Flanges must be free of dirt, grease, and other materials that may adversely affect bond of joint treatment. Provide prefinished or job decorated materials.

2.1.7 Asphalt Impregnated Building Felt

Provide a 15 lb asphalt moisture barrier over glass mat covered or reinforced gypsum sheathing. Conforming to ASTM D226/D226M Type 1 (No. 15) for asphalt impregnated building felt.

2.1.8 Sound Control Insulation

Mineral wool acoustical batts, Refer to Section 07 21 16 for material requirements.

2.1.9 Water

Provide clean, fresh, and potable water.

PART 3 EXECUTION

3.1 EXAMINATION

3.1.1 Framing and Furring

Verify that framing and furring are securely attached and of sizes and spacing to provide a suitable substrate to receive gypsum board. Verify that all blocking, headers and supports are in place to support cabinets, food service equipment and similar items. Do not proceed with work until framing and furring are acceptable for application of gypsum board.

3.1.2 Masonry Walls

Verify that surfaces of masonry walls to receive gypsum board are dry, free of dust, oil, protrusions and voids, and any other foreign matter.

Do not proceed with work until surfaces are acceptable for application of gypsum board.

3.1.3 Building Construction Materials

Do not install building construction materials that show visual evidence of biological growth.

3.2 APPLICATION OF GYPSUM BOARD

Apply gypsum board to framing and furring members in accordance with [ASTM C840](#) or [GA 216](#) and the requirements specified. Apply gypsum board with separate panels in moderate contact; do not force in place. Stagger end joints of adjoining panels. Neatly fit abutting end and edge joints. Use gypsum board of maximum practical length; select panel sizes to minimize waste. Cut out gypsum board to make neat, close, and tight joints around openings. In vertical application of gypsum board, provide panels in lengths required to reach full height of vertical surfaces in one continuous piece. Lay out panels to minimize waste; reuse cutoffs whenever feasible. Treat edges of cutouts for plumbing pipes, screwheads, and joints with water-resistant compound as recommended by the gypsum board manufacturer. Provide type of gypsum board for use in each system specified herein as indicated.

3.2.1 Glass Mat Covered or Fiber Reinforced Gypsum Sheathing

Apply glass mat covered or fiber reinforced gypsum sheathing in accordance to gypsum association publications [GA 253](#). Follow gypsum sheathing manufacturer's requirements of design details for joints and fasteners and be properly installed to protect the substrate from moisture intrusion. Do not leave exposed surfaces of the glass mat covered or fiber reinforced gypsum sheathing beyond the manufacturer's recommendation without a weather barrier cladding. Properly flash the openings. Seal all joints, seams, and penetrations with a compatible silicone sealant.

3.2.2 Floating Interior Angles

Minimize framing by floating corners with single studs and drywall clips. Locate the attachment fasteners adjacent to ceiling and wall intersections in accordance with [ASTM C840](#), System XII or [GA 216](#).

3.2.3 Control Joints

Install expansion and contraction joints in ceilings and walls in accordance with [ASTM C840](#), System XIII or [GA 216](#).

3.2.4 Expansion Joints

Where unbroken gypsum board runs in walls exceed 30 feet in length (in runs with door or window openings and exceeding 20 feet), provide expansion joints so as to limit runs to 20 feet maximum. Generally locate joints in pairs above each jamb of doors and similar openings. Where no opening occurs in an overrun, space joints as equidistant as is practical.

Divide ceilings (of over 400 sf or 30 feet in length) into sections not exceeding 150 sf. Limit undivided exterior ceilings to 16 foot runs and 100 sf. Arrange pattern so that joints intersect duct openings and other points of weakness in system.

Each edge shall occur on a separate bearing stud spaced 1/4 inch apart, and secured with 1/2 inch staples 6 inches oc per manufacturer's directions. Where such joints occur in fire or sound rated partitions, space bearing studs 3/4 inch apart and fill space between studs with safing insulation before finish is applied.

3.3 FINISHING OF GYPSUM BOARD

Tape and finish gypsum board in accordance with ASTM C840, GA 214 and GA 216. Finish plenum areas above ceilings to Level 1 in accordance with GA 214. Finish water resistant gypsum backing board, ASTM C1396/C1396M, to receive ceramic tile to Level 2 in accordance with GA 214. Finish walls and ceilings to receive a heavy-grade wall covering to Level 3 in accordance with GA 214. Finish walls and ceilings without critical lighting to receive flat paints, light textures, or wall coverings to Level 4 in accordance with GA 214. Unless otherwise specified, finish all gypsum board walls, partitions and ceilings to Level 5 in accordance with GA 214. Provide joint, fastener depression, and corner treatment. Tool joints as smoothly as possible to minimize sanding and dust. Do not use self-adhering fiber glass mesh tape with conventional drying type joint compounds; use setting or hardening type compounds only. Provide treatment for water-resistant gypsum board as recommended by the gypsum board manufacturer. Protect workers, building occupants, and HVAC systems from gypsum dust.

3.3.1 Uniform Surface

Wherever gypsum board is to receive eggshell, semigloss or gloss paint finish, or where severe, up or down lighting conditions occur, finish gypsum wall surface in accordance with GA 214 Level 5. In accordance with GA 214 Level 5, apply a thin skim coat of joint compound to the entire gypsum board surface, after the two-coat joint and fastener treatment is complete and dry.

3.4 SEALING

Seal openings around pipes, fixtures, and other items projecting through gypsum board and cementitious backer units as specified in Section 07 92 00 JOINT SEALANTS. Apply material with exposed surface flush with gypsum board or cementitious backer units.

3.4.1 Sealing for Glass Mat or Reinforced Gypsum Board Sheathing

Apply silicone sealant in a 3/8 inch bead to all joints and trowel flat. Apply enough of the same sealant to all fasteners penetrating through the glass mat gypsum board surface to completely cover the penetration when troweled flat. Do not place construction and materials behind sheathing until a visual inspection of sealed joints during daylight hours has been completed by Contracting Officer.

3.5 SOUND RATED ASSEMBLIES

When sound rated assemblies are required, provide materials and application methods, including insulation, types and spacing of fasteners, in accordance with the contract document and the description of the assembly in the ASTM E90 Factory Test Report. Seal partitions continuously with acoustical foam or sealant (both sides) and finished to match wall wherever it abuts another element such as the floor, ceiling, wall, column, mullion, or another system or assembly.

3.6 PATCHING

Patch surface defects in gypsum board to a smooth, uniform appearance, ready to receive finishes.

-- End of Section --

SECTION 09 30 10

CERAMIC, QUARRY, AND GLASS TILING
08/20

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI A108/A118/A136.1 (2019) American National Standard
Specifications for the Installation of
Ceramic Tile

ANSI A137.1 (2019) American National Standards
Specifications for Ceramic Tile

ASTM INTERNATIONAL (ASTM)

ASTM C241/C241M (2021) Standard Test Method for Abrasion
Resistance of Stone Subjected to Foot
Traffic

ASTM C373 (2018) Standard Test Methods for
Determination of Water Absorption and
Associated Properties by Vacuum Method for
Pressed Ceramic Tiles and Glass Tiles and
Boil Method for Extruded Ceramic Tiles and
Non-tile Fired Ceramic Whiteware Products

ASTM C648 (2020) Standard Test Method for Breaking
Strength of Ceramic Tile

CALIFORNIA DEPARTMENT OF PUBLIC HEALTH (CDPH)

CDPH SECTION 01350 (2010; Version 1.1) Standard Method for
the Testing and Evaluation of Volatile
Organic Chemical Emissions from Indoor
Sources using Environmental Chambers

MARBLE INSTITUTE OF AMERICA (MIA)

MIA Design Manual (2016) Dimension Stone Design Manual

SCIENTIFIC CERTIFICATION SYSTEMS (SCS)

SCS SCS Global Services (SCS) Indoor Advantage

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT (SCAQMD)

SCAQMD Rule 1168 (2017) Adhesive and Sealant Applications

TILE COUNCIL OF NORTH AMERICA (TCNA)

TCNA Hdbk (2017) Handbook for Ceramic, Glass, and
Stone Tile Installation

UNDERWRITERS LABORATORIES (UL)

UL 2818 (2013) GREENGUARD Certification Program
For Chemical Emissions For Building
Materials, Finishes And Furnishings

1.2 SUBMITTALS

Government approval is required for submittals . Submit the following in
accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Detail Drawings

SD-03 Product Data

Porcelain Tile

Recycled Content for Porcelain Tile

Transition Strips

Mortar, Grout, and Adhesive

Cementitious Backer Units

Waterproof Membrane

Crack Isolation Membrane

SD-04 Samples

Tile

Accessories

Transition Strips

Grout

SD-07 Certificates

Indoor Air Quality for Sealants

Water Absorption Rates

SD-08 Manufacturer's Instructions

Manufacturer's Approved Cleaning Instructions

SD-10 Operation and Maintenance Data

Porcelain Tile, Data Package 1

Transition Strips, Data Package 1

1.3 CERTIFICATIONS

1.3.1 Indoor Air Quality Certifications

Provide products certified to meet indoor air quality requirements by **UL 2818** (Greenguard) Gold, **SCS** Global Services Indoor Advantage Gold or provide certification or validation by other third-party programs that products meet the requirements of this Section. Provide current product certification documentation from certification body. When product does not have certification, provide validation that product meets the indoor air quality product requirements cited in this Section.

1.3.2 Water Absorption Rates Certification

Provide certification for each tile type indicating compliance with the following water absorption (wa) rates per **ANSI A137.1** criteria as tested per **ASTM C373** requirements.

- a. Porcelain **Floor** Tile (Impervious): Provide water absorption (wa) of 0.1 percent or less.
- b. Ceramic Wall Tile (Non-Vitreous): Provide maximum water absorption (wa) of 7.0 percent.

1.4 QUALITY ASSURANCE

Provide installers having a minimum of two years of experience with a company specializing in performing the type of work described. Each type and color of tile to be provided from a single source. Each type and color of mortar, adhesive, and grout to be provided from the same source.

1.5 DELIVERY, STORAGE, AND HANDLING

Ship tiles in sealed packages and clearly marked with the grade, type of tile, producer identification, and country of origin. Deliver materials to the project site in manufacturer's original unopened containers with seals unbroken and labels and hallmarks intact. Protect materials from weather, and store them under cover in accordance with manufacturer's printed instructions. Store and handle tiles per manufacturer's instructions for gauged porcelain tile and gauged porcelain tile panels/slabs.

1.6 ENVIRONMENTAL REQUIREMENTS

Do not perform ceramic tile work unless the substrate and ambient temperature is at least **50 degrees F** and rising. Maintain temperature above **50 degrees F** while the work is being performed and for at least 7 days after completion of the work. When temporary heaters are used, ventilate the area to the outside to avoid carbon dioxide damage to new tilework.

1.7 WARRANTY

Provide manufacturer's warranty to repair or replace defective tiling materials and workmanship, including tile, mortar and grout products and installation as a system, for a period of one year from date of final

acceptance of the work..

1.8 EXTRA MATERIALS

Supply one full undamaged box of each type tile used in clean and marked cartons.

PART 2 PRODUCTS

2.1 TILE

Provide tiles that comply with ANSI A137.1 and are standard grade tiles. Provide a minimum breaking strength of 125 lbs. for wall tile and 250 lbs. for floor tile in accordance with ASTM C648. Provide floor tiles with a minimum wet dynamic coefficient of friction (DCOF) value of 0.42 when tested in accordance with ANSI A137.1 requirements. For materials like tile, accessories, and transition strips submit samples of sufficient size to show color range, pattern, type and joints.

Submit manufacturers' descriptive product data for each type of ceramic, tiling indicated. Include manufacturers' literature, finishes, profiles and thicknesses of materials.

Submit manufacturers' operations and maintenance data for each type of ceramic tiling indicated in accordance with Section 01 78 23 OPERATIONS AND MAINTENANCE DATA.

2.1.1 Porcelain Tile Mark PT 1 and PT 2

Provide through body (surface color and pattern go all the way through the tile body), rectified porcelain tile with cove and bullnose base and trim pieces. Blend tiles in factory and in a packages to have same color range and continuous blend for installation. Provide nominal tile size(s) as indicated below.

Provide porcelain tiling materials that contain a minimum of 10 percent recycled content. Provide data identifying percentage of recycled content for porcelain tile.

2.1.2 Porcelain Tile Mark PT 3

Provide glazed color body (body of tile is stained to match the glaze color), porcelain tile and trim pieces. Blend tiles in factory and in packages to have same color range and continuous blend for installation. Provide nominal tile size(s) as indicated below.

Provide porcelain tile materials that contain a minimum of 10 percent recycled content. Provide data identifying percentage of recycled content for porcelain tile.

2.2 WATER

Provide potable water.

2.3 MORTAR, GROUT, AND ADHESIVE

Provide bond coat, mortar, and grout supplied from the same manufacturer.

2.3.1 Latex-Portland Cement Mortar

TCNA Hdbk.

2.3.2 Ceramic Tile Grout

TCNA Hdbk; petroleum-free and plastic-free high-performance cement grout (latex-portland cement grout).

2.3.3 Sealants

Comply with applicable regulations regarding toxic and hazardous materials and as specified. Provide sealant that does not change the color or alter the appearance of the grout. Refer to Section 07 92 00 JOINT SEALANTS.

Provide sealants used on the interior of the building (defined as inside of the weatherproofing system) meeting either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of SCAQMD Rule 1168. For products located on the interior of the building (inside of the weatherproofing system), provide certification or validation of indoor air quality for sealants.

2.4 SUBSTRATES

2.4.1 Cementitious Backer Units

Provide cementitious backer unit, for use as tile substrate as indicated, in accordance with TCNA Hdbk. Furnish 5/8 inch thick cementitious backer units.

2.5 MISCELLANEOUS TRIMS

2.5.1 Transition Strips

Provide marble transitions at locations indicated. Categorize marble Group A as classified by MIA Design Manual. Provide a fine sand-rubbed finish marble, white in color. Threshold shall have beveled or rounded edges with edge thickness set to receive abutting finish. Provide minimum 12.0 marble abrasion when tested in accordance with ASTM C241/C241M.

2.6 WATERPROOF MEMBRANE

2.6.1 General

Manufacturer's standard product that complies with ANSI A108/A118/A136.1 and is recommended by the manufacturer for the application indicated. Include reinforcement and accessories recommended by manufacturer.

2.7 CRACK ISOLATION MEMBRANE

2.7.1 General

Manufacturer's standard product that complies with ANSI A108/A118/A136.1 and is recommended by the manufacturer for the application indicated. Include reinforcement and accessories recommended by manufacturer.

2.7.2 Chlorinated-Polyethylene Crack Isolation Membrane

Nonplasticized, chlorinated polyethylene faced on both sides with nonwoven polyester fabric; 0.030 inch nominal thickness.

2.8 COLOR, TEXTURE, AND PATTERN

Provide color, pattern and texture as indicated; colors listed are not intended to limit the selection of equal colors from other manufacturers..

Basis of Design for color and texture is based on Stone Peak Ceramics Quartzite and Shadow collections.

Mark PT-1 (Floor): 2" x 2" x 3/8 inch thick, Quartzite, color Iron.

Mark PT-2 (Wall): 12" x 24"x 3/8 inch thick, Quartzite, color Lime.

Mark PT-3 (Wall & Millwork): 4"x12"x 3/8 inch thick, Shadow, color Smoke.

PART 3 EXECUTION

3.1 PREPARATORY WORK AND WORKMANSHIP

Inspect surface to receive tile in conformance to the requirements of TCNA Hdbk for surface conditions for the type setting bed specified and for workmanship. Provide variations of tiled surfaces that fall within maximum values shown below:

TYPE	WALLS	FLOORS
Latex-Portland Cement Mortar	1/8 inch in 8 ft.	1/8 inch in 10 ft.

3.2 GENERAL INSTALLATION REQUIREMENTS

Do not start tile work until roughing in for mechanical and electrical work has been completed and tested, and built-in items requiring membrane waterproofing have been installed and tested. Close space, in which tile is being set, to traffic and other work. Keep closed until tile is firmly set. Do not start floor tile installation in spaces requiring wall tile until after wall tile has been installed. Apply tile in colors and patterns indicated in the area shown on the drawings. Install tile with the respective surfaces in true even planes to the elevations and grades shown. Provide special shapes as required for sills, jambs, recesses, offsets, external corners, and other conditions to provide a complete and neatly finished installation. Solidly back tile bases and coves with mortar. Do not walk or work on newly tiled floors without using kneeling boards or equivalent protection of the tiled surface. Keep traffic off horizontal portland cement mortar installations for at least 72 hours. Keep all traffic off epoxy installed floors for at least 40 hours after grouting, and heavy traffic off for at least 7 days, unless otherwise specifically authorized by manufacturer. Completed work shall be free of hollow sounding areas, and loose, cracked and defective tiles. Dimension and draw detail drawings at a minimum scale of 1/4 inch = 1 foot. Include drawings of pattern at inside corners, outside corners, termination points and location of all equipment items such as thermostats, switch plates, mirrors and toilet accessories mounted on surface. Submit drawings showing ceramic tile pattern elevations. Submit manufacturer's preprinted

installation instructions.

Do not install building construction materials that show visual evidence of biological growth.

3.3 INSTALLATION OF SUBSTRATES

3.3.1 Cementitious Backer Units

Install in accordance with manufacturer's written instructions.

3.4 INSTALLATION OF WALL TILE

Install wall tile in accordance with the TCNA Hdbk, method W244 over cementitious backer board and method W202 over masonry wall, with grout joints as recommended by the manufacturer for the type of tile. Join carefully and closely to trim, fixtures, electrical boxes, etc. Cut and drill neatly as required; splitting of pieces not permitted. Where tile extends to plaster ceiling, complete ceiling before tile work.

3.4.1 Ceramic Tile Grout

Prepare and install ceramic tile grout in accordance with TCNA Hdbk method for each installation method. Provide and apply manufacturer's standard product for sealing grout joints in accordance with manufacturer's recommendations.

3.5 INSTALLATION OF FLOOR TILE

Install floor tile in accordance with TCNA Hdbk method F113 and with grout joints as recommended by the manufacturer for the type of tile. Dress tile to floor drains.

3.5.1 Latex-Portland Cement

Use latex-portland cement mortar to install tile directly over properly cured, plane, clean concrete slabs in accordance with TCNA Hdbk method F113. Use latex-portland cement when installing porcelain ceramic tile.

3.5.2 Wall Expansion Joints

Where unbroken runs of material exceed 20 feet, provide 3/16" urethane caulked vertical joints. Locate joints to coincide with expansion joints in substrate, and to align with expansion joints in floor tile where they occur. Where wall tile butts against a restricting surface (column, doorframe, etc.), rake out joint and caulk.

3.5.3 Waterproof and Crack Isolation Membranes

Install as indicated in accordance with manufacturer's written instructions.

3.5.4 Concrete Fill

Provide a leveling bed (sloped as indicated) composed of 1 :5 mortar/sand bed, properly mixed and cured prior to setting tile

3.6 INSTALLATION OF MISCELLANEOUS TRIMS

3.6.1 Transition Strips

Install transition strips where indicated, in a manner similar to that of the ceramic tile floor and as recommended by the manufacturer. Provide thresholds full width of the opening. Install head joints at ends not exceeding 1/4 inch in width and grouted full.

3.6.2 Metal Trims

Install trim where indicated. Embed anchoring leg in setting mortar in accordance with manufacturer's instructions. During grouting of tile joints, immediately wipe grout from finish surface.

3.7 EXPANSION JOINTS

Form and seal joints as specified in Section 07 92 00 JOINT SEALANTS.

3.7.1 Walls

Provide expansion joints at control joints in backing material. Wherever backing material changes, install an expansion joint to separate the different materials.

3.7.2 Floors

Provide expansion joints over construction joints, control joints, and expansion joints in concrete slabs in accordance with TCNA Hdbk method EJ171 type to suit conditions. Provide expansion joints where tile abuts restraining surfaces such as perimeter walls, curbs and columns and at intervals of 20 to 25 feet each way in large interior floor areas. and 8 to 12 feet each way in large exterior areas or areas exposed to direct sunlight or moisture. Extend expansion joints through setting-beds and fill.

3.8 CLEANING AND PROTECTING

Upon completion, thoroughly clean tile surfaces in accordance with manufacturer's approved cleaning instructions. Do not use acid for cleaning glazed tile. Clean floor tile with resinous grout or with factory mixed grout in accordance with printed instructions of the grout manufacturer. After the grout has set, provide a protective coat of a noncorrosive soap or other approved method of protection for tile wall surfaces. Cover tiled floor areas with building paper before foot traffic is permitted over the finished tile floors. Provide board walkways on tiled floors that are to be continuously used as passageways by workmen. Replace damaged or defective tiles.

-- End of Section --

SECTION 09 51 00

ACOUSTICAL CEILINGS

08/20

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM A580/A580M	(2018) Standard Specification for Stainless Steel Wire
ASTM A641/A641M	(2019) Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire
ASTM C423	(2009a) Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method
ASTM C635/C635M	(2022) Standard Specification for Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-In Panel Ceilings
ASTM C636/C636M	(2013) Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels
ASTM C834	(2017) Standard Specification for Latex Sealants
ASTM E413	(2022) Classification for Rating Sound Insulation
ASTM E1111/E1111M	(2014; R 2022) Standard Test Method for Measuring the Interzone Attenuation of Open Office Components
ASTM E1264	(2022) Standard Classification for Acoustical Ceiling Products
ASTM E1414/E1414M	(2021a) Standard Test Method for Airborne Sound Attenuation Between Rooms Sharing a Common Ceiling Plenum
ASTM E1477	(1998; R 2022a) Standard Test Method for Luminous Reflectance Factor of Acoustical Materials by Use of Integrating-Sphere Reflectometers

CALIFORNIA DEPARTMENT OF PUBLIC HEALTH (CDPH)

CDPH SECTION 01350 (2010; Version 1.1) Standard Method for
the Testing and Evaluation of Volatile
Organic Chemical Emissions from Indoor
Sources using Environmental Chambers

GREEN SEAL (GS)

GS-36 (2013) Adhesives for Commercial Use

SCIENTIFIC CERTIFICATION SYSTEMS (SCS)

SCS SCS Global Services (SCS) Indoor Advantage

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT (SCAQMD)

SCAQMD Rule 1168 (2017) Adhesive and Sealant Applications

UNDERWRITERS LABORATORIES (UL)

UL 2818 (2013) GREENGUARD Certification Program
For Chemical Emissions For Building
Materials, Finishes And Furnishings

1.2 SUBMITTALS

Government approval is required for submittals. Submit the following in
accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Drawings

SD-03 Product Data

Acoustical Performance

SD-04 Samples

Acoustical Units

SD-06 Test Reports

SD-07 Certificates

Indoor Air Quality for Adhesives

Indoor Air Quality for Sealants

1.3 CERTIFICATIONS

1.3.1 Indoor Air Quality Certifications

1.3.1.1 Ceiling Tiles

Provide products certified to meet indoor air quality requirements by
UL 2818 (Greenguard) Gold, SCS Global Services Indoor Advantage Gold or
provide certification or validation by other third-party programs that

products meet the requirements of this section. Provide current product certification documentation from certification body.

1.3.1.2 Adhesives and Sealants

Provide products certified to meet indoor air quality requirements by **UL 2818** (Greenguard) Gold, **SCS** Global Services Indoor Advantage Gold or provide certification or validation by other third-party programs that products meet the requirements of this Section. Provide current product certification documentation from certification body. When product does not have certification, provide validation that product meets the indoor air quality product requirements cited in this Section.

1.4 DELIVERY, STORAGE. AND HANDLING

Deliver materials to the site in the manufacturer's original unopened containers with brand name and type clearly marked. Carefully handle and store materials in dry, watertight enclosures. Immediately before installation, store acoustical units for not less than 24 hours at the same temperature and relative humidity as the space where they will be installed in order to assure proper temperature and moisture acclimation.

1.5 ENVIRONMENTAL REQUIREMENTS

Maintain a uniform temperature of not less than **60 degrees F** nor more than **85 degrees F** and a relative humidity of not more than 70 percent for 24 hours before, during, and 24 hours after installation of acoustical units.

1.6 SCHEDULING

Complete and dry interior finish work such as plastering, concrete and terrazzo work before ceiling installation. Complete mechanical, electrical, and other work above the ceiling line; install and start operating heating, ventilating, and air conditioning systems in order to maintain temperature and humidity requirements.

1.7 WARRANTY

Provide manufacturer's warranty to repair or replace defective materials and workmanship including but not limited to, sagging and warping of panels and rusting and of grid systems, for a period of ten years from date of final acceptance of the work.

1.8 EXTRA MATERIALS

Furnish **one or more full undamaaged cartons of of each type of ceiling panel**, from the same lot as those installed, of each color and style. The quantity of each type shall be at least 1 percent of ceiling area represented by that color or design..

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

Provide sound controlling units mechanically mounted on a ceiling suspension system for acoustical treatment. Provide the unit size, texture, finish, and color as specified. Coordinate the entire ceiling system with other details, like the location of access panels and ceiling penetrations, for instance, shown on the drawings. Submit **drawings**

showing the the location, extent and details of acoustical treatment including suspension system, method of anchoring and fastening, and reflected ceiling plan.

2.1.1 Acoustical Performance

2.1.1.1 Ceiling Sound Transmission

Provide ceiling systems with the specified Ceiling Attenuation Class (CAC) ratings as determined in accordance with [ASTM E1414/E1414M](#) and [ASTM E413](#). Provide sound attenuators over light fixtures, air terminals and other ceiling penetrations, provide acoustical blanket insulation on top of the ceiling or adjacent to partitions to provide lightweight acoustical plenum barriers above partitions as required to achieve the specified CAC ratings. Provide test ceiling continuous at the partition and assembled in the suspension system in the same manner that the ceiling will be installed on the project.

2.1.1.2 Ceiling Sound Absorption

Determine the Noise Reduction Coefficient (NRC) in accordance with [ASTM C423](#). Determine Articulation Class (AC) in accordance with [ASTM E1111/E1111M](#).

2.1.2 Light Reflectance

Determine light reflectance factor in accordance with [ASTM E1477](#) test method.

2.2 ACOUSTICAL UNITS

Provide color, pattern and texture as indicated; colors listed are not intended to limit the selection of equal products from other manufacturers.

Submit samples of each type of acoustical unit and each type of suspension grid tee section showing texture, finish, and color. Conform acoustical units to [ASTM E1264](#), Class A, and the following requirements:

2.2.1 Units for Exposed-Grid System

2.2.1.1 Lay-in Ceiling Board (ABD-1)

24 inch x 24 inch x 3/4 inch square edge board with NRC .70, white, similar to USG's "Eclipse ClimaPlus" with NRC . 70, item # 76575.

2.7. 2.2.1.2 Lay-in Ceiling Board (ABD-2)

24 inch x 24 inch x 3/4 inch square edge nubby cloth face board with NRC .85, white, similar to USG's "Premier Nubby ClimaPlus" board, item # 7000G.

2.2.2 Humidity Resistant Composition Units (ABD-FS)

24 inchx 24 inch x 1/2 inch thick square-edge vinyl face sheetrock panel equal to USG's "Sheetrock Lay-in Ceiling Panel ClimaPlus", item 3260.

2.2.3 Overlay Panels

Provide precut 5/8 inch glass mat faced gypsum board panels and install (above scheduled ceiling board) over ceiling panels for fastening diffusers, lights, etc.

2.3 SUSPENSION SYSTEM

Provide standard **exposed-grid** standard width flange suspension system conforming to **ASTM C635/C635M** for heavy-duty systems. Provide surfaces exposed to view of aluminum with a factory-applied white baked-enamel finish. Provide **channel shaped, hemmed** wall molding having a flange of not less than **15/16 inch**, of **0.021 inch minimum material thickness, matching grid system in material and finish**. Provide inside and outside corner caps. Provide a suspension system with a maximum deflection of 1/360 of the span length capable of supporting the finished ceiling, light fixtures, air diffusers, and accessories, as shown.

2.4 HANGERS

Provide hangers and attachment capable of supporting a minimum **300 pound** ultimate vertical load without failure of supporting material or attachment.

2.4.1 Wires

Conform wires to **ASTM A641/A641M**, Class 1, **0.08 inch (12 gauge)** in diameter. **At food service area support wire shall be ASTM A580/A580M**, composition 302 or 304, condition annealed stainless steel, **0.08 inch (12 gauge)** in diameter.

2.5 ACCESS PANELS

Provide access panels that match adjacent acoustical units, designed and equipped with suitable framing and fastenings for removal and replacement without damage. Size panel to be not less than **12 by 12 inch** or more than **12 by 24 inch**.

- a. Attach an identification plate of **0.032 inch** thick aluminum, **3/4 inch** in diameter, stamped with the letters "AP" and finished the same as the unit, near one corner on the face of each access panel.
- b. Identify ceiling access panel by a number utilizing white identification plates or plastic buttons with contrasting numerals. Provide plates or buttons of minimum **1 inch** diameter and securely attached to one corner of each access unit. Provide a typewritten card framed under glass listing the code identification numbers and corresponding system descriptions listed above. Mount the framed card where directed and furnish a duplicate card to the Contracting Officer. Code identification system is as follows:
 - (1) Fire detection/alarm system
 - (2) Air conditioning controls
 - (3) Plumbing system
 - (4) Heating and steam systems
 - (5) Air conditioning duct system
 - (6) Sprinkler system

2.6 ADHESIVE

Use adhesive as recommended by tile manufacturer. Provide non-aerosol adhesive products used on the interior of the building (defined as inside of the weatherproofing system) that meet either emissions requirements of [CDPH SECTION 01350](#) (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of [SCAQMD Rule 1168](#). Provide aerosol adhesives used on the interior of the building that meet either emissions requirements of [CDPH SECTION 01350](#) (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of [GS-36](#). For products located on the interior of the building (inside of the weatherproofing system), provide certification or validation of [indoor air quality for adhesives](#).

2.7 FINISHES

Use manufacturer's standard textures, patterns and finishes as specified for acoustical units and suspension system members. Treat ceiling suspension system components to inhibit corrosion.

2.8 COLORS AND PATTERNS

Use colors and patterns for acoustical units and suspension system components as indicated; colors listed are not intended to limit the selection of equal colors from other manufacturers.

2.9 ACOUSTICAL SEALANT

Conform acoustical sealant to [ASTM C834](#), nonstaining. Provide sealants used on the interior of the building (defined as inside of the weatherproofing system) that meet either emissions requirements of [CDPH SECTION 01350](#) (limit the requirements for either office or classroom spaces regardless of space type) or VOC content requirements of [SCAQMD Rule 1168](#). For products located on the interior of the building (inside of the weatherproofing system), provide certification of [indoor air quality for Sealants](#).

PART 3 EXECUTION

3.1 INSTALLATION

Do not install building construction materials that show visual evidence of biological growth.

Examine surfaces to receive directly attached acoustical units for unevenness, irregularities, and dampness that would affect quality and execution of the work. Rid areas, where acoustical units will be cemented, of oils, form residue, or other materials that reduce bonding capabilities of the adhesive. Complete and dry interior finish work such as plastering, concrete, and terrazzo work before installation. Complete and approve mechanical, electrical, and other work above the ceiling line prior to the start of acoustical ceiling installation. Provide acoustical work complete with necessary fastenings, clips, and other accessories required for a complete installation. Do not expose mechanical fastenings in the finished work. Lay out hangers for each individual room or space. Provide hangers to support framing around beams, ducts, columns, grilles, and other penetrations through ceilings. Keep main runners and carrying channels clear of abutting walls and partitions. Provide at least two main runners for each ceiling span. Wherever required to bypass an object

with the hanger wires, install a subsuspension system so that all hanger wires will be plumb.

Where a specific edge treatment is not stated and a choice exists, provide the more esthetically desirable method. Field rabbeting of border and special pieces must be done expertly so that fit appears to be as neat as factory rabbets.

Install ceilings level within a tolerance of 1 in 500, and straight within a tolerance of 1 in 1000 (kinking hanger wire to achieve leveling will not be allowed).

Fit units in string joint pattern symmetrically with walls and so that light fixtures, columns, etc. fit properly into the pattern. Avoid borders less than half-size. Consult Architect regarding layout before proceeding. Refer to reflected ceiling plan. Report any partitions which are not square or true to line.

3.1.1 Suspension System

Install suspension system in accordance with **ASTM C636/C636M** and as specified herein. Do not suspend hanger wires or other loads from underside of steel decking.

3.1.1.1 Plumb Hangers

Install hangers plumb and not pressing against insulation covering ducts and pipes. Where lighting fixtures are supported from the suspended ceiling system, provide hangers at a minimum of four hangers per fixture and located not more than **6 inch** from each corner of each fixture.

3.1.1.2 Splayed Hangers

Splay (slope or slant) hangers around obstructions, offsetting the resulting horizontal force by bracing, countersplaying, or other acceptable means.

3.1.2 Wall Molding

Provide wall molding where ceilings abut vertical surfaces. Miter corners where wall moldings intersect or install corner caps. Secure wall molding not more than **3 inch** from ends of each length and not more than **16 inch** on centers between end fastenings. Provide wall molding springs at each acoustical unit in semi-exposed or concealed systems.

3.1.3 Acoustical Units

Install acoustical units in accordance with the approved installation instructions of the manufacturer. Ensure that edges of acoustical units are in close contact with metal supports, with each other, and in true alignment. Arrange acoustical units so that units less than one-half width are minimized. Hold units in exposed-grid system in place with manufacturer's standard hold-down clips, if units weigh less than **1 psf** or if required for fire resistance rating.

Where incandescent light fixtures, exit signs, smoke detectors, signal lights and non-modular grilles occur, glue Overlay Board to top side of the tile receiving the device.

3.1.4 Acoustical Sealant

Seal all joints around pipes, ducts or electrical outlets penetrating the ceiling. Apply a continuous ribbon of acoustical sealant on vertical web of wall or edge moldings.

3.2 CEILING ACCESS PANELS

Locate ceiling access panels directly under the items which require access.

3.3 CLEANING

Following installation, clean dirty or discolored surfaces of acoustical units and leave them free from defects. Remove units that are damaged or improperly installed and provide new units as directed.

-- End of Section --

SECTION 09 65 00

RESILIENT FLOORING
08/10, CHG 3: 08/18

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D4078	(2002; R 2015) Water Emulsion Floor Polish
ASTM E648	(2019a) Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source
ASTM F710	(2021) Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring
ASTM F1700	(2020) Standard Specification for Solid Vinyl Floor Tile
ASTM F1861	(2021) Standard Specification for Resilient Wall Base
ASTM F1869	(2022) Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride
ASTM F2170	(2019a) Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes

CALIFORNIA DEPARTMENT OF PUBLIC HEALTH (CDPH)

CDPH SECTION 01350	(2010; Version 1.1) Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources using Environmental Chambers

GREEN SEAL (GS)

GS-36	(2013) Adhesives for Commercial Use

SCIENTIFIC CERTIFICATION SYSTEMS (SCS)

SCS	SCS Global Services (SCS) Indoor Advantage

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT (SCAQMD)

SCAQMD Rule 1168	(2017) Adhesive and Sealant Applications

UNDERWRITERS LABORATORIES (UL)

UL 2818

(2013) GREENGUARD Certification Program
For Chemical Emissions For Building
Materials, Finishes And Furnishings

1.2 SUBMITTALS

Government approval is required for submittals. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Resilient Flooring and Accessories

SD-03 Product Data

Resilient Flooring and Accessories

Adhesives

Luxury Vinyl Tile

Wall Base

SD-04 Samples

Resilient Flooring and Accessories

SD-06 Test Reports

Moisture, Alkalinity and Bond Tests

SD-07 Certificates

Indoor Air Quality for Adhesives

SD-08 Manufacturer's Instructions

Surface Preparation

Installation

SD-10 Operation and Maintenance Data

Resilient Flooring and Accessories;

1.3 CERTIFICATES

1.3.1 Indoor Air Quality

Submit required indoor air quality certifications and validations in one submittal package.

1.3.1.1 Floor Covering Materials

Provide Luxury Vinyl Tile, and wall base products certified to meet indoor air quality requirements by FLOORSCORE, UL 2818 (Greenguard) Gold, SCS Global Services Indoor Advantage Gold or provide certification by other

third-party programs. Provide current product certification documentation from certification body.

1.3.1.2 Adhesives, Caulking and Sealants

Provide products certified to meet indoor air quality requirements by **UL 2818** (Greenguard) Gold, **SCS** Global Services Indoor Advantage Gold or provide certification or validation by other third-party programs that products meet the requirements of this Section. Provide current product certification documentation from certification body. When product does not have certification, provide validation that product meets the indoor air quality product requirements cited herein.

1.4 DELIVERY, STORAGE, AND HANDLING

Deliver materials to the building site in original unopened containers bearing the manufacturer's name, style name, pattern color name and number, production run, project identification, and handling instructions. Store materials in a clean, dry, secure, and well-ventilated area with ambient air temperature maintained above **68 degrees F** and below **85 degrees F**, stacked according to manufacturer's recommendations. Protect materials from the direct flow of heat from hot-air registers, radiators and other heating fixtures and appliances. Observe ventilation and safety procedures specified in the MSDS.

1.5 ENVIRONMENTAL REQUIREMENTS

Maintain areas to receive resilient flooring at a temperature above **68 degrees F** and below **85 degrees F** for 3 days before application, during application and 2 days after application, unless otherwise directed by the flooring manufacturer for the flooring being installed. Maintain a minimum temperature of **55 degrees F** thereafter. Provide adequate ventilation to remove moisture from area and to comply with regulations limiting concentrations of hazardous vapors.

1.6 SCHEDULING

Schedule resilient flooring application after the completion of other work which would damage the finished surface of the flooring.

1.7 WARRANTY

Provide manufacturer's standard performance **20 year limited commercial wear warranty**.

1.8 EXTRA MATERIALS

Provide **one undamaged full box of** extra flooring material of each color and pattern of **Luxury Vinyl Tile**. Provide extra wall base material composed of **20 linear feet** of each type, color and pattern. Package all extra materials in original properly marked containers bearing the manufacturer's name, brand name, pattern color name and number, production run, and handling instructions. Provide extra materials from the same lot as those installed. Leave extra stock at the site in location assigned by Contracting Officer.

PART 2 PRODUCTS

2.1 LUXURY VINYL TILE

Conform to [ASTM F1700](#) Class III printed film with a minimum wear layer thickness 0.030 inch (30 mil) and minimum overall thickness 0.197 inch with non slip/skid backing, Type B (embossed). Provide 10 x 40 inch tile.

Textured Wood Grain style simulating a rustic Hickory color and pattern.

Provide tile with a factory protective finish that enhances cleanability and durability.

2.2 WALL BASE

Conform to [ASTM F1861](#), Type TS (vulcanized thermoset rubber), Style A (straight - installed with carpet). Provide 4 inch high and a minimum 1/8 inch thick wall base. Provide job formed corners in matching height, shape, and color. .

2.3 REDUCER STRIPS

Provide at edges where tile work terminates. To be continuous vinyl strip, 1-5/8 inches wide, solid color as selected, with self-stick back. Where tile dies against another material such as ceramic tile, butt tightly with top surfaces level, without a reducer strip.

2.4 ADHESIVES

Provide adhesives for flooring, base and accessories as recommended by the manufacturer and comply with local indoor air quality standards. Submit manufacturer's descriptive data, documentation stating physical characteristics, and mildew and germicidal characteristics.

Provide non-aerosol adhesive products used on the interior of the building (defined as inside of the weatherproofing system) that meet either emissions requirements of [CDPH SECTION 01350](#) (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of [SCAQMD Rule 1168](#). Provide aerosol adhesives used on the interior of the building that meet either emissions requirements of [CDPH SECTION 01350](#) (use the office or classroom requirements, regardless of space type) or VOC content requirements of [GS-36](#). Provide certification or validation of [indoor air quality for adhesives](#).

2.5 SURFACE PREPARATION MATERIALS

Provide surface preparation materials, such as [leveling compound](#) and floor crack fillers as recommended by the flooring manufacturer for the subfloor conditions.

2.6 Leveling Compound

Provide a complete system to allow leveling, and crack infilling of the existing concrete floor substrate. Examine the exposed floor prior to work to assess the recommended system.

2.7 POLISH/FINISH

Provide polish finish as recommended by the manufacturer and conform to [ASTM D4078](#) for polish.

2.8 CAULKING AND SEALANTS

Provide caulking and sealants in accordance with Section 07 92 00 JOINT SEALANTS.

2.9 MANUFACTURER'S COLOR, PATTERN AND TEXTURE

Provide color, pattern and texture for resilient flooring and accessories selected from manufacturer's standard colors. Color listed is not intended to limit the selection of equal colors from other manufacturers. Provide flooring in any one continuous area or replacement of damaged flooring in continuous area from same production run with same shade and pattern. Submit scaled drawings indicating patterns (including location of patterns and colors) and dimensions. Submit manufacturer's descriptive data and three samples of each indicated color and type of flooring, base, mouldings, and accessories sized a minimum 2-1/2 by 4 inch. Submit Data Package 1 in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

2.10 FIRE RESISTANCE TESTING REQUIREMENTS

Provide a minimum average critical radiant flux of 0.22 watts per square centimeter for flooring in corridors and exits when tested in accordance with ASTM E648.

PART 3 EXECUTION

3.1 EXAMINATION

Examine and verify that site conditions are in agreement with the design package. Report all conditions that will prevent a proper installation. Do not take any corrective action without written permission from the Government. Work will proceed only when conditions have been corrected and accepted by the installer. Submit manufacturer's printed installation instructions for all flooring materials and accessories, including preparation of substrate, seaming techniques, and recommended adhesives.

3.2 SURFACE PREPARATION

Provide a smooth, true, level plane for surface preparation of the flooring, except where indicated as sloped. Floor to be flat to within 3/16 inch in 10 feet. Prepare subfloor in accordance with flooring manufacturer's recommended instructions. The Contractor has the option to install new resilient tile over the existing fully adhered resilient floor finish (using leveling compounds if necessary); to install new underlayment; or to remove existing finish and all adhesive residue. Prepare the surfaces of the existing flooring substrate as recommended by the flooring manufacturer. Comply with ASTM F710 for concrete subfloor preparation. Floor fills or toppings may be required as recommended by the flooring manufacturer. Install underlayments, when required by the flooring manufacturer, in accordance with manufacturer's recommended printed installation instructions. Before any work under this section is begun, correct all defects such as rough or scaling concrete, chalk and dust, cracks, low spots, high spots, and uneven surfaces. Repair all damaged portions of concrete slabs as recommended by the flooring manufacturer. Remove concrete curing and sealer compounds from the slabs, other than the type that does not adversely affect adhesion. Remove paint, varnish, oils, release agents, sealers, waxes, and adhesives, as required by the flooring product in accordance with manufacturer's printed

installation instructions.

3.3 MOISTURE, ALKALINITY AND BOND TESTS

Determine the suitability of the concrete subfloor for receiving the resilient flooring with regard to moisture content and pH level by moisture and alkalinity tests. Conduct moisture testing in accordance with ASTM F1869 or ASTM F2170, unless otherwise recommended by the flooring manufacturer. Conduct alkalinity testing as recommended by the flooring manufacturer. Determine the compatibility of the resilient flooring adhesives to the concrete floors by a bond test in accordance with the flooring manufacturer's recommendations. Submit copy of test reports for moisture and alkalinity content of concrete slab, and bond test stating date of test, person conducting the test, and the area tested.

3.4 GENERAL INSTALLATION

Do not install building construction materials that show visual evidence of biological growth.

3.5 PLACING LUXURY VINYL TILES

Install luxury vinyl tile flooring using glue down installation. Install flooring and accessories in accordance with manufacturer's printed installation instructions. Prepare and apply adhesives in accordance with manufacturer's directions for installation method specified. Keep tile lines and joints square, symmetrical, tight, and even. Keep each floor in true, level plane, except where slope is indicated. Vary edge width as necessary to maintain full-size tiles in the field, no edge tile to be less than one-half the field tile size, except where irregular shaped rooms make it impossible. Cut flooring to fit around all permanent fixtures, built-in furniture and cabinets, pipes, and outlets. Cut, fit, and scribe edge tile to walls and partitions after field flooring has been applied.

3.6 PLACING REDUCER STRIPS

Install reducer strips at edges where tile work terminates in accordance with manufacturer's printed installation instructions. Prepare and apply adhesives in accordance with manufacturer's printed directions.

3.7 PLACING WALL BASE

Install wall base in accordance with manufacturer's printed installation instructions. Prepare and apply adhesives in accordance with manufacturer's printed directions. Tighten base joints and make even with adjacent resilient flooring. Fill voids along the top edge of base at masonry walls with caulk. Roll entire vertical surface of base with hand roller, and press toe of base with a straight piece of wood to ensure proper alignment. Avoid excess adhesive in corners.

3.8 CLEANING

Immediately upon completion of installation of flooring in a room or an area, dry and clean the flooring and adjacent surfaces to remove all surplus adhesive. After tile has sufficiently seated itself (approximately 14 days after laying), thoroughly sweep or vacuum the flooring to remove all loose dirt and grit. Clean flooring as recommended in accordance with manufacturer's printed maintenance instructions and within the recommended

time frame. As required by the manufacturer, apply the recommended number of coats and type of polish and finish in accordance with manufacturer's written instructions.

3.9 PROTECTION

From the time of installation until acceptance, protect flooring from damage as recommended by the flooring manufacturer. Remove and replace flooring which becomes damaged, loose, broken, or curled and wall base which is not tight to wall or securely adhered.

-- End of Section --

SECTION 09 67 23.13
STANDARD RESINOUS FLOORING
11/19

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D570	(1998; E 2010; R 2010) Standard Test Method for Water Absorption of Plastics
ASTM D638	(2014) Standard Test Method for Tensile Properties of Plastics
ASTM D696	(2016) Standard Test Method for Coefficient of Linear Thermal Expansion of Plastics Between -30 degrees C and 30 degrees C With a Vitreous Silica Dilatometer
ASTM D4259	(2018) Standard Practice for Preparation of Concrete by Abrasion Prior to Coating Application
ASTM F2170	(2019a) Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes

1.2 ADMINISTRATIVE REQUIREMENTS

1.2.1 Pre-Installation Meetings

Pre-installation Conference: Conduct conference at Project site.

1.2.2 Product Data

Within 30 days of contract award, submit [manufacturer's catalog data](#) for the following items:

- a. Concrete Primer
- b. Impact resistant Self-leveling membrane
- c. Epoxy-Resin Binder/Matrix
- d. Flake Aggregate
- e. Surface Sealing Coat

1.2.3 Design Mix Data

Within 30 days of contract award, submit **design mix data** for the following items, including a complete list of ingredients and admixtures:

- a. **Concrete Primer**
- b. **Impact resistant Self-leveling membrane**
- c. **Epoxy-Resin Binder/Matrix**
- d. **Surface Sealing Coat**

Ensure applicable test reports verify the mix has been successfully tested and meets design requirements.

1.3 SUBMITTALS

Government approval is required for submittals . Submit the following in accordance with Section **01 33 00** SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Installation Drawings

SD-03 Product Data

Manufacturer's Catalog Data

SD-04 Samples

Hardboard Mounted Epoxy Flooring

Floor Topping

Mockups

SD-05 Design Data

Design Mix Data

SD-07 Certificates

Listing of Product Installations

Referenced Standards Certificates

SD-11 Closeout Submittals

Warranty

1.4 DELIVERY, STORAGE, AND HANDLING

Protect materials from weather, soil, and damage during delivery, storage, and construction. Deliver materials in original packages, containers, or bundles bearing brand name and name of material.

Maintain materials used in the installation of floor topping at a temperature between **65 and 85 degrees F**.

1.5 QUALITY CONTROL

Prior to commencement of work, submit [referenced standards certificates](#) for the following, showing conformance with the referenced standards contained in this section:

- a. Concrete Primer
- b. Impact resistant Self-leveling membrane
- c. Epoxy-Resin Binder/Matrix
- d. Flake Aggregate
- e. Surface Sealing Coat

1.5.1 Mockups

Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution. Apply full-thickness mockups on [96 inch](#) square floor area selected by Contracting Officer. Simulate finished lighting conditions for the review of mockups.

1.5.2 Qualifications

Submit a [listing of product installations](#) for heavy duty epoxy flooring including identification of at least 5 units, similar to those proposed for use, that have been in successful service for a minimum period of 5 years. Identify purchaser, address of installation, service organization, and date of installation.

Ensure floor system applicators are experienced in the application of [self leveling](#) aggregate thin-set floor topping.

1.5.3 Sampling

Submit [hardboard mounted epoxy flooring](#) samples not less than [12 inch](#) square for each required color.

Provide panels showing nominal thickness of finished toppings, color, and texture of finished surfaces. Finished floor toppings and the approved samples are to match in color and texture.

1.6 WARRANTY

Submit a 2 year written [warranty](#) for all materials and installation work.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

Submit [installation drawings](#) for a [self leveling reactive resin](#) flooring systems clearly designating the areas of application and the installation plan. Include in the installation plan, methods to control sand and dust if sand blasting is required.

- A. The flooring system is a 4-6mm (3/16"-1/4") thick troweled surfacing

composite of a 100 percent reactive binder resin and decorative filler flakes with the manufacturer's recommended primer and topcoat.

- B. The flooring coating system shall cure completely and be available to normal operations in no more than 90 minutes at Temperatures as low as 0 °C. after application of the final coat.
- C. The finished floor coating system shall be uniform in color combinations, texture, and appearance. All edges that terminate at walls, floor discontinuities, and other embedded items shall be sharp, uniform, and cosmetically acceptable with no thick or ragged edges.
- D. All resins must be manufactured and tested under an ISO 9001 registered quality system and ISO 14001 ecology management system.

2.2 MATERIALS

2.2.1 Mixes

2.2.1.1 Concrete Primer

- 1. Percentage Reactive Resin: 100%
- 2. Percentage Solids: 100%
- 3. Water Absorption, Wt. % (ASTM D570): less than 0.06
- 4. Tensile Strength, psi (ASTM D638): 3,550 psi.
- 5. Tensile Modulus, psi X 10 to the 5th (ASTM D638): 2.1
- 6. Coefficient of Thermal Expansion, in./in./deg. F (ASTM D696): 0.000035
- 7. Electrical Resistivity (ASTM D257):
 - Volume Resistance, ohm-cm: 10¹⁵
 - Surface Resistance, ohm: 10¹²
- 8. Water Vapor Transmission (DIN 53122), g/cm-hr-mm Hg X 10⁻⁶: 1.4

2.2.1.2 Self Leveling Membrane Coating

A solvent-free, 2-component methacrylic resin of high impact resistance and low-temperature flexibility whose highly-molecular structure makes it outstandingly suitable for self-leveling coatings subject to extreme stresses,

Viscosity at +20 °C	DIN 53 015	1000 mPa · s
Flow time at +20 °C, 6 mm cup	ISO 2431	135 – 165 sec.
Density D4 20	DIN 51 757	0.98 g/cm ³
Flash point	DIN 51 755	+10 °C
Pot life at +20°C (100 g, 2 % pbw. hardening powder)		approx. 15 min.
Application temperature		+5 °C to +30 °C

2.2.1.3 Epoxy-Resin Binder/Matrix

Provide a clear two-component compatible system **medium-viscosity methacrylic resin** binder which individually cures the epoxy resin at room temperature to a glossy smooth film. Ensure the two components and the cured epoxy binder have the following physical properties:

1. Percentage of reactive resin: 100%
2. Percentage of solids: 100%
3. Water Absorption, Wt. % (ASTM D570): 0.04
4. Compressive Strength, psi (ASTM C109): 6,000-8,000 psi.
(ASTM D695): 6,000 psi.
6. Tensile Strength, psi (ASTM D638): 3,625 psi.
7. Tensile Modulus, psi (ASTM D638): 720,000 psi.
8. Flexural Strength, psi (ASTM D790): 3,500 psi.
9. Coefficient of Thermal Expansion,
in./in./deg. F (ASTM D696): 0.000019
10. Electrical Resistivity, (ASTM D257)
Volume Resistance, ohm-cm: 1014
11. Chemical Resistance, ASTM D543:
 - Effect of weak acids: none
 - Effect of strong acids: slight
 - Effect of alkalis: none
 - Effect of salt solutions: none
 - Effect of oil, grease: none
 - Effect of sunlight (UV radiation): none

2.2.1.4 Color Flake

Colored quartz flakes supplied by the resinous flooring manufacturer. Color blend as selected from manufacturer's standard selection by the Architect.

2.2.1.5 Slip Resistant Aggregate

Provide aluminum oxide aggregate recommended by the resinous flooring manufacturer and approved by the Contracting Officer. Deliver aggregate to the site in three separate package gradations for blending. Gradations are:

SIEVE SIZE	PERCENT	
	MAXIMUM	MINIMUM
GRADUATION NO. 1		
Retained on No. 6	0.0	-
Passing No. 6, retained on No. 8	5.0	0.0
Passing No. 8, retained on No. 12	100.0	74.0
Passing No. 20	1.0	-

	PERCENT	
SIEVE SIZE	MAXIMUM	MINIMUM
GRADATION NO. 2		
Retained on No. 16	0.0	-
Passing No. 16, retained on No. 18	5.0	0.0
Passing No. 18, retained on No. 40	100.0	85.0
Passing No. 40, retained on No. 60	9.0	0.0
Passing No. 60	1.0	-
GRADATION NO. 3		
Retained on No. 20	0.0	-
Passing No. 20, retained on No. 35	5.0	0.0
Passing No. 35, retained on No. 60	100.0	80.0
Passing No. 60, retained on No. 100	13.0	0.0
Passing No. 100	2.0	-

2.2.1.6 Surface Sealing Coat

Provide a reactive, solvent-free, low-viscosity, virtually non-yellowing 2-component methacrylic resin offering good resistance to water interaction.

- Percentage Reactive Resin: 100%
- Percentage Solids: 100%
- Water Absorption, Wt.% (ASTM D570): 0.5
- Tensile Strength, psi (ASTM D638): 3,555 psi.
- Tensile Modulus, psi (ASTM D638): 210,000 psi.
- Coefficient of Thermal Expansion, (ASTM D696) n./in./deg. F: 0.000035
- Electrical Resistivity (ASTM D257):
Volume Resistance, ohm-cm: 10¹⁵
Surface Resistance, ohm: 10¹²
- Water Vapor Transmission, (DIN 53122) g/cm-hr-mm Hg X 10⁻⁹: 1.43
- Chemical Resistance, ASTM D543:

Effect of weak acids:	none
Effect of strong acids:	slight
Effect of alkalis:	none
Effect of salt solutions:	none
Effect of oil, grease:	none
Effect of sunlight (UV radiation):	none

PART 3 EXECUTION

3.1 PREPARATION

Prior to applying resinous flooring material, inspect substrate and immediately report any unsatisfactory conditions that exist and repair.

Verify that the concrete substrates are dry and the moisture-vapor emissions are within acceptable levels according to the manufacturer's written instructions.

Relative Humidity Test: Use in situ probes, [ASTM F2170](#). Proceed with installation only after substrates have a maximum 85 percent relative humidity level measurement.

Alkalinity and Adhesion Testing: Verify that concrete substrates have a pH within an acceptable range. Perform tests recommended by the manufacturer. Proceed with the application only after the substrates pass testing.

3.1.1 Safety Precautions

Prior to application in confined spaces of toppings and coatings containing flammable or toxic properties, institute safety precautions recommended by the manufacturer of the product.

Erect "NO SMOKING" signs, and prohibit smoking or use of spark- or flame-producing devices within 50 feet of any mixing or placing operation involving flammable materials.

Provide the personnel required to handle, mix, or apply toppings containing toxic or flammable properties with such items of personal protective equipment and apparel for eye, skin, and respiratory protection as are recommended by the manufacturer of the product. Ensure all personnel are trained in the appropriate use and wearing of personal protection equipment.

3.1.2 Protection of Adjacent Surfaces

In addition to the protection of adjacent surfaces during installation, provide areas used to store and mix materials with a protective covering under the materials. After application of the sealer coats, protect finished flooring during the remainder of the construction period. In areas of expected minimum or moderate traffic, cover floors with 70 pound kraft paper, with strips taped together and edges secured to prevent roll-up. Place vegetable fiberboard, plywood, or other suitable material that does not mar the flooring over the paper to protect areas used as passages by workmen and areas subject to floor damage because of subsequent building operations. Upon completion of construction, remove the protection, clean flooring and, where necessary, repair, reseal, or both, at no additional cost to the Government.

3.1.3 Concrete Subfloor

3.1.3.1 New Concrete Floors

Do not commence installation of the floor topping until the concrete has cured a minimum of 28 calendar days. Verify that the concrete floor is straight, properly sloped, and has wooden float type finish. Ensure that the concrete is moist cured with burlap or polyethylene. Before applying the primer coat, clean the concrete surface by an approved method.

3.1.3.2 Existing Concrete Floors

Clean existing concrete floors, with hard troweled or contaminated areas in conformance with [ASTM D4259](#). Ensure the concrete is free of all paint, sealers, curing agents, oil, grease, moisture, dirt or any other contaminants. Remove any loose or corroded segments of existing concrete. Patch with a grouting compound as recommended by the resinous flooring manufacturer. Fill all cracks with an elastomeric jointing compound compatible with the resinous flooring system used.

3.1.4 Mixing Of Materials

Select the job mix proportions on the trial batch proportions used to prepare the [floor topping](#) samples as submitted and approved.

Open only the containers of component materials to be use in each specific application as needed. Refer to Manufacturer's data sheets for pot-life/temperature relationship to determine size of batches to mix and mix ratios for each respective coat of the system. Measure, add, and mix the hardener component into the respective resin components in the proportions recommended by the Material Manufacturer. Pot life is short, so mix only as much material at a time as can be easily and efficiently applied.

Use mechanical equipment for mixing of materials in accordance with the manufacturer's instructions.

Use rotating paddle-type masonry mortar mixers for preblending the [color flakes](#) and addition of the mixed epoxy resin binder. Ensure mixing times are as recommended by the materials supplier(s), provided mixing times result in homogeneous mixtures. Limit quantity of material mixed at one time to that which can be applied and finished within the working life of the mixtures. Verify that the temperature of materials at the time of mixing are between [65 and 85 degrees F](#).

3.2 APPLICATION

3.2.1 Areas of Application

Anchor plates set with the top surface at or above the finished epoxy floor level do not require coverage with this flooring material. Extend flooring under equipment, except when the equipment base is indicated to be flush against the structural floor. Cover and/or mask surfaces not to receive the epoxy floor topping, such as equipment or cabinets installed prior to surface-preparation efforts and adjacent to the flooring installation.

3.2.2 Application of Prime Coat

Mix primer components according to manufacturers instructions.

Ensure that the prepared subfloor surface is dry and at a temperature of not less than 60 degrees F when application of the floor topping is initiated. Immediately before application of the primecoat on the prepared surface, remove dust or other loose particles by blowing with compressed air or vacuum cleaned. Use only an air compressor equipped with an efficient oil-water trap to prevent oil contamination or wetting of surface.

Pour the primer mixture batches onto the floor surface using a thick-napped, solvent resistant paint roller to roll out the material at a rate of 100 sq. ft./ gal. to form a uniform, continuous film, ensuring that all crevices, cracks, other surface discontinuities have been saturated and coated. Use a paint brush to reach areas inaccessible to the roller. Work quickly and deliberately; the pot life is short (10 -15 minutes). Do not leave any "puddles"; roll out any such accumulations.

Allow the primer coat to cure. If any of the concrete has absorbed all of the primer or if the concrete still has a dry look, reprime these areas before applying the next layer.

3.2.3 Flexible Membrane

- A. Size the batches, and mix according to Manufacturer's instructions. The entire batch should be poured and spread at once, do not let material set in pail.
- B. Spread the membrane material with a gauge rake set to a depth of 1/16 inch. Lightly trowel to a uniform thickness of 1/16 inch as necessary.
- C. Allow the membrane to cure.

3.2.4 Binder Matrix

- A. Size the batches, and mix according to Manufacturer's instructions. The entire batch should be poured and spread at once, do not let material set in pail.
- B. Spread the binder matrix material with a gauge rake set to a depth of 3/16". Lightly trowel to a uniform thickness of 3/16" as necessary.
- C. If necessary, roll with a porcupine roller to release trapped air.
- D. Broadcast the color flakes into the fresh material before it begins to cure at a rate of 0.15 - 0.25 pounds per sf. Broadcast by hand, or use a backpack type blower or sand blast pot to achieve an even broadcast. The flakes must 'rain' down and not be thrown into the wet base coat.
- E. Allow the binder matrix layer to cure.
- F. Remove excess flakes by sweeping, "blow-down", and/or vacuuming.

3.2.5 Sealer Coat

After the floor binder matrix layer has set firmly (approximately 6 to 16 hours depending on subfloor temperature) in a relatively dust-free

environment, apply two thin coats of the sealer coat, by means of brush, roller, squeegee, or notched trowel to provide a pore-free, easy-to-clean surface **per the manufacturer's instructions**. At the time of sealer application, ensure that the surface is dust-free. Depending on relative humidity, allow the applied sealer to cure to a tack-free condition in 2 to 4 hours. Do not apply second coat until after the initial coat has cured to a tack-free, hard film. Maintain topping areas in a relatively dust-free environment during curing of the sealer coats.

3.3 FIELD QUALITY CONTROL

3.3.1 Repairing

Remove and replace damaged or unacceptable portions of completed work with new work to match adjacent surfaces at no additional cost to the Government.

3.4 ADJUSTING AND CLEANING

Clean surfaces of the new work, and adjacent surfaces soiled as a result of the work. Remove all equipment, surplus materials, and rubbish associated with the work from the site.

-- End of Section --

SECTION 09 72 00

WALLCOVERINGS
08/17, CHG 1: 08/18

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM E84 (2020) Standard Test Method for Surface Burning Characteristics of Building Materials

CALIFORNIA DEPARTMENT OF PUBLIC HEALTH (CDPH)

CDPH SECTION 01350 (2010; Version 1.1) Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources using Environmental Chambers

GREEN SEAL (GS)

GS-36 (2013) Adhesives for Commercial Use

GYPSUM ASSOCIATION (GA)

GA 214 (2010) Recommended Levels of Gypsum Board Finish

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 286 (2019) Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth

SCIENTIFIC CERTIFICATION SYSTEMS (SCS)

SCS SCS Global Services (SCS) Indoor Advantage

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT (SCAQMD)

SCAQMD Rule 1168 (2017) Adhesive and Sealant Applications

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FS CCC-W-408 (Rev D; Notices 1, 2, 3) Wallcovering, Vinyl Coated

UNDERWRITERS LABORATORIES (UL)

UL 723 (2018) UL Standard for Safety Test for Surface Burning Characteristics of

Building Materials

UL 2818

(2013) GREENGUARD Certification Program
For Chemical Emissions For Building
Materials, Finishes And Furnishings

1.2 SUBMITTALS

Government approval is required for submittals . Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Wallcoverings and Accessories

Primer and Adhesive

Recycled Content for wallcovering

SD-04 Samples

Wallcoverings and Accessories

SD-07 Certificates

Indoor Air Quality

SD-08 Manufacturer's Instructions

Wallcoverings and Accessories

SD-10 Operation and Maintenance Data

Wallcoverings and Accessories

1.3 CERTIFICATIONS

1.3.1 Indoor Air Quality Certifications

Submit required indoor air quality certifications and validations in one submittal package.

1.3.1.1 Fabrics and Wallcoverings

Provide products certified to meet indoor air quality requirements by UL 2818 (Greenguard) Gold, SCS Global Services Indoor Advantage Gold or provide certification or validation by other third-party program that products meet the requirements of this Section. Provide current product certification documentation from certification body.

1.3.1.2 Primers and Adhesives

Provide products certified to meet indoor air quality requirements by UL 2818 (Greenguard) Gold, SCS Global Services Indoor Advantage Gold or provide certification or validation by other third-party programs that products meet the requirements of this Section. Provide current product certification documentation from certification body. When product does not have certification, provide validation that product meets the indoor air quality product requirements cited herein.

1.4 DELIVERY, STORAGE, AND HANDLING

Deliver the material to the site in manufacturer's original wrappings and packages and clearly label with the manufacturer's name, brand name, pattern and color name and number, dye lot number, size, and other related information. Store in a safe, dry, clean, and well-ventilated area at temperatures not less than 50 degrees F and within a relative humidity range of 30 to 60 percent. Store wallcovering material in a flat position and protected from damage, soiling, and moisture. Do not open containers until needed for installation, unless verification inspection is required.

1.5 ENVIRONMENTAL REQUIREMENTS

Comply with wallcovering manufacturer's printed installation instructions for minimum temperature of area to receive requirements for conditioning adhesive and wallcovering. Provide a minimum 50 degrees F area temperature, 72 hours prior to installation, during installation, and until the adhesive dries. Observe ventilation and safety procedures.

1.6 WARRANTY

Provide manufacturer's standard performance guarantees or warranties that extend beyond a one-year period.

1.7 EXTRA MATERIALS

Provide one extra full roll of each type and pattern of wallcovering installed. Provide the same manufacturer, type, pattern, color, and lot number of extra stock as the installed wallcovering. Provide full rolls, packed for storage and marked with content, manufacturer's name, pattern and color name and number and dye lot number. Leave extra stock at the site at a location as directed by the Contracting Officer.

PART 2 PRODUCTS

2.1 WALLCOVERINGS AND ACCESSORIES

Provide wall coverings and accessories material designed specifically for the specified use. Provide vinyl wallcovering and borders with a mercury, cadmium, lead, and chromium free base. Protect wallcoverings with bactericides and mildew inhibitors against microbiological and mildew growth.

2.1.1 Product Data

- a. Wallcovering: Submit manufacturer's descriptive data, documenting physical characteristics, flame resistance, mildew and germicidal characteristics for wallcovering.
- b. Accessories: Submit manufacturer's descriptive data for corner guard and wainscot cap.
- c. Primer and Adhesive: Submit manufacturer's descriptive data, documenting physical characteristics, mildew and germicidal characteristics.

2.1.2 Samples

2.1.2.1 Wallcovering

Provide three samples, 3 yards long by the width specified, of each type to be installed in the work, as required to illustrate material weight, color, shade, decorative design, and embossing when required.

2.1.2.2 Wallcovering Mockup Panels

After samples are approved, and prior to starting installation, provide a minimum 8 by 8 foot wallcovering mock-up for each color and type of vinyl, and fabric wallcovering, using the proposed primers and adhesives and actual substrate materials. Once approved, use the mock-up samples as a standard of workmanship for installation within the facility. Written notification to the Contracting Officer at least 48 hours prior to mock-up installation.

2.1.3 Certificates

Submit manufacturer's statement attesting that the product furnished meets or exceeds specification requirements. Date the statement after the award of the contract, state Contractor's name and address, name the project and location, and list the requirements being certified. Include these certificates:

- (1) Certified laboratory test reports of the physical properties for vinyl wallcovering, as specified.
- (2) Certificates of Compliance for UL fire hazard classification listing, as specified.
- (3) Certificates of Compliance for contact adhesive.

2.1.4 Manufacturer's Instructions

Submit preprinted installation instructions for wallcovering and accessories, adhesives and primers. Include substrate preparation and material application in the instructions.

2.1.5 Operations and Maintenance Data

- a. Submit Data Package 1 in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.
- b. Submit copies of manufacturer's maintenance instructions for each type of vinyl wallcovering and accessory describing recommended type of cleaning equipment and materials, spotting and cleaning methods, and cleaning cycles. Instructions to also include preventative maintenance, recommended cleaning materials and precautions in the use of cleaning materials that may be detrimental to the wallcovering surface and accessories when improperly applied.

2.2 VINYL WALLCOVERING Mark VWC 2 and 3

Provide a 100 percent Non-phthalate Vinyl fabric with Polyester/Cotton Osnaburg backing. Conform to FS CCC-W-408 for vinyl wallcovering, Type II (Medium Duty) with a minimum total weight of 13 ounces/square yard and 20 ounces/linear yard. Provide width of 52/54 inch. Test vinyl wallcovering

in accordance with NFPA 286 or meet the requirements of Class A when tested in accordance with ASTM E84 or UL 723.

Mark VWC-2: Columns in Main Dining 110; Maharam - Filigree 300040-021 Leeward

Mark VWC-3: Executive Dining 130; Maharam - Filigree 300040-018 Gargoyle

Provide certification of indoor air quality for vinyl wallcovering.

2.3 VINYL WALLCOVERING Mark VWC-1

Location: Ice Cream Counter and North Wall at Entrance 100

Provide colorfast, stain, and soil resistant vinyl wallcovering fabricated of 100 percent Cellulose with polyester backing. Meet the requirements of Class A when tested in accordance with ASTM E84 or UL 723. Comply with or exceed the following for Mark VWC-1 wallcovering:

Width: 52 inches

Bolt size: 30 yards

Weight 8.5 ounces/linear yard

Color and style basis: Maharam - Lever 300051-005 Resonance

Provide Vinyl Wallcovering containing a minimum of 5 percent recycled content. Provide data identifying percentage of recycled content for wallcovering.

2.4 WALL LINER

Provide a non-woven polyester cellulose blend wall liner having a minimum weight of 3.7 ounces/square yard and a total minimum thickness of 0.013 inch. Test wall liner in accordance with NFPA 286 or have a Class A flame spread rating of 0-25 and smoke development rating of 0-450 when tested in accordance with ASTM E84 or UL 723.

Provide certification of indoor air quality for wall liner.

2.5 PRIMER AND ADHESIVE

Provide a type primer and adhesive recommended by the wallcovering manufacturer, containing a non-mercury based mildewcide, and complying with local indoor air quality standards. Primer must permit removal of the wallcovering and protect the wall surface during removal. Do not damage gypsum wallboard facing paper during removal of wallcovering. Provide a strippable type adhesive. When substrate color variations show through vinyl wallcovering, provide a white pigmented primer as recommended by the wallcovering manufacturer used to conceal the variations. Provide a recommended type adhesive to install corner guards and wainscot cap by the manufacturer of the corner guards and wainscot cap.

Provide primers and non-aerosol adhesive products used on the interior of the building (defined as inside of the weatherproofing system) that meet either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of SCAQMD Rule 1168. Provide aerosol adhesives used on the interior of the building that meet either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of GS-36.

Provide certification or validation of indoor air quality for primer; also, provide certification or validation of indoor air quality for adhesives.

2.6 COLOR, TEXTURE, AND PATTERN

Manufacturer, style and color indicated above are provided as basis of design and are not intended to limit the selection of equal products from other manufacturers. Final approval of style and color as determined by the Contracting Officer.

PART 3 EXECUTION

3.1 EXAMINATION

Inspect all areas and conditions under which wallcoverings are to be installed. Notify the Contracting Officer, in writing, of any conditions detrimental to the proper and timely completion of the installation. Work will proceed only when conditions have been corrected and accepted by the installer.

3.2 SURFACE PREPARATION

Do not apply wallcovering to surfaces that are rough, that contain stains which will bleed through the wallcovering, or that are otherwise unsuitable for proper installation. Fill cracks and holes; sand rough spots smooth. Finish walls to receive presentation dry erase wallcovering to a Level 4 gypsum wallboard finish in accordance with GA 214 unless Level 5 is recommended by the wallcovering manufacturer. Thoroughly dry surfaces at least 30 days prior to installation of vinyl wallcovering. Provide interior surfaces of new and existing gypsum wallboard with a wallcovering primer in accordance with the manufacturer's printed instructions. As required, use white primer when substrate color variations are visible through thin or light color wallcovering. Seal interior surfaces of exterior masonry walls to prevent moisture penetration, then prime with a wallcovering primer in accordance with the manufacturer's printed instructions. Provide masonry walls with flush joints. Test moisture content of plaster, concrete, and masonry with an electric moisture meter of a maximum five percent reading. Apply a thin coat of joint compound or cement plaster, as recommended by the wallcovering manufacturer, to the concrete and masonry walls as a substrate preparation. To promote adequate adhesion of wall lining over masonry walls, prime the walls as recommended by the wall lining manufacturer. Prime the surfaces of walls as required by the manufacturer's printed instructions to permit ultimate removal of wallcovering from the wall surfaces. Allow primer to completely dry before adhesive application.

3.3 INSTALLATION

Do not install building construction materials that show visual evidence of biological growth.

3.3.1 Wallcovering

Install wallcovering in accordance with the manufacturer's printed installation instructions. Remove glue and adhesive spillage from wallcovering face and seams with a remover recommended by the manufacturer.

3.3.2 Wall Liner

Install wall liner over masonry walls that are to receive wallcovering. Install liner in accordance with the manufacturer's printed installation instructions. Install liner perpendicular to wallcovering to prevent overlapping of seams between liner and wallcovering.

3.4 CLEAN-UP

Upon completion of the work, clean wallcovering free of dirt, soiling, stain, or residual film. Remove and clean surplus materials, rubbish, and debris resulting from the wallcovering installation.

-- End of Section --

SECTION 09 90 00

PAINTS AND COATINGS
02/21

PART 1 GENERAL

1.1 RELATED REQUIREMENTS

1.1.1 Painting Included

Where a space or surface is indicated to be painted, include the following unless indicated otherwise.

- A. Typical wood, gypsum board and ferrous metal surfaces
- B. Interior masonry surfaces (except as deleted below)
- C. Interior concrete except floors
- D. Covers of electric service panels (in finished areas)
- E. Mechanical piping, etc., in typical finished areas (see below)
- F. Previously painted surfaces in existing spaces where indicated on finish schedules to be refinished (not stained surfaces); see Part Refinishing.
- G. Touch-up work and new surfaces at incidental alterations of existing structure
- H. All existing previously painted surfaces where modified, soiled or damaged as a result of this work.

1.1.2 Painting Excluded:

The following portions may be left unpainted, or work is specified under other Sections:

- A. Interior and exterior caulking (see Division 7)
- B. Exterior Wall Coating
- C. Glass
- D. Stainless steel and typical non-ferrous metal surfaces
- E. Piping, tanks, etc. in Mechanical Rooms (see Mechanical Division)
- F. Concrete floors (see Concrete Division for hardening treatment)
- I. Factory applied prime coats (except touching-up and finish coats)
- J. Factory applied finish coats (except touching up)
- K. All surfaces in duct spaces
- L. Galvanized roof deck

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN CONFERENCE OF GOVERNMENTAL INDUSTRIAL HYGIENISTS (ACGIH)

ACGIH 0100 (2017; Suppl 2020) Documentation of the Threshold Limit Values and Biological Exposure Indices

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME A13.1 (2020) Scheme for the Identification of Piping Systems

ASTM INTERNATIONAL (ASTM)

ASTM C920 (2018) Standard Specification for Elastomeric Joint Sealants

ASTM D235 (2002; R 2012) Mineral Spirits (Petroleum Spirits) (Hydrocarbon Dry Cleaning Solvent)

ASTM D523 (2014; R 2018) Standard Test Method for Specular Gloss

ASTM D4214 (2007; R 2015) Standard Test Method for Evaluating the Degree of Chalking of Exterior Paint Films

ASTM D4263 (1983; R 2018) Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method

ASTM D4444 (2013; R 2018) Standard Test Method for Laboratory Standardization and Calibration of Hand-Held Moisture Meters

ASTM D6386 (2016a) Standard Practice for Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Painting

ASTM F1869 (2022) Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride

CENTERS FOR DISEASE CONTROL AND PREVENTION (CDC)

Intelligence Bulletin 65 (2013) Occupational Exposure to Carbon Nanotubes and Nanofibers

MASTER PAINTERS INSTITUTE (MPI)

MPI 4 (2016) Interior/Exterior Latex Block Filler

MPI 5	(2015) Primer, Exterior Alkyd Wood
MPI 6	(2015) Primer, Exterior Latex Wood
MPI 9	(2016) Alkyd, Exterior Gloss (MPI Gloss Level 6)
MPI 11	(2016) Latex, Exterior Semi-Gloss, MPI Gloss Level 5
MPI 16	(2016) Stain, Exterior, Water Based, Solid Hide
MPI 21	(2012) Heat Resistant Coating, (Up to 205°C/402°F), MPI Gloss Level 6
MPI 23	(2015) Primer, Metal, Surface Tolerant
MPI 38	(2016) Elastomeric Coating, Exterior, Water Based, Non-Flat
MPI 39	(2018) Primer, Latex, for Interior Wood
MPI 47	(2016) Alkyd, Interior, Semi-Gloss (MPI Gloss Level 5)
MPI 50	(2015) Primer Sealer, Latex, Interior
MPI 52	(2016) Latex, Interior, (MPI Gloss Level 3)
MPI 56	(2012) Varnish, Interior, Polyurethane, Oil Modified, Gloss
MPI 57	(2012) Varnish, Interior, Polyurethane, Oil Modified, Satin
MPI 72	(2016) Polyurethane, Two-Component, Pigmented, Gloss (MPI Gloss Level 6-7)
MPI 76	(2016) Primer, Alkyd, Quick Dry, for Metal
MPI 79	(2016) Primer, Alkyd, Anti-Corrosive for Metal
MPI 90	(2012) Stain, Semi-Transparent, for Interior Wood
MPI 94	(2016) Alkyd, Exterior, Semi-Gloss (MPI Gloss Level 5)
MPI 95	(2015) Primer, Quick Dry, for Aluminum
MPI 101	(2016) Primer, Epoxy, Anti-Corrosive, for Metal
MPI 107	(2016) Primer, Rust-Inhibitive, Water Based
MPI 113	(2018) Elastomeric, Pigmented, Exterior, Water Based, Flat

MPI 134	(2015) Primer, Galvanized, Water Based
MPI 139	(2016) Latex, Interior, High Performance Architectural, (MPI Gloss Level 3)
MPI 141	(2016) Latex, Interior, High Performance Architectural, Semi-Gloss (MPI Gloss Level 5)
MPI 144	(2016) Latex, Interior, Institutional Low Odor/VOC, (MPI Gloss Level 2)
MPI 145	(2016) Latex, Interior, Institutional Low Odor/VOC, (MPI Gloss Level 3)
MPI 149	(2016) Primer Sealer, Interior, Institutional Low Odor/VOC
MPI 153	(2016) Light Industrial Coating, Interior, Water Based, Semi-Gloss (MPI Gloss Level 5)
MPI 161	(2016) Light Industrial Coating, Exterior, Water Based (MPI Gloss Level 3)
MPI 163	(2016) Light Industrial Coating, Exterior, Water Based, Semi-Gloss (MPI Gloss Level 5)
MPI 164	(2016) Light Industrial Coating, Exterior, Water Based, Gloss (MPI Gloss Level 6)
MPI ASM	(2019) Architectural Painting Specification Manual
MPI GPS-1-14	(2014) Green Performance Standard GPS-1-14
MPI GPS-2-14	(2014) Green Performance Standard GPS-2-14
MPI MRM	(2015) Maintenance Repainting Manual

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC 7/NACE No.4	(2007) Brush-Off Blast Cleaning
SSPC Glossary	(2011) SSPC Protective Coatings Glossary
SSPC PA 1	(2016) Shop, Field, and Maintenance Coating of Metals
SSPC SP 1	(2015) Solvent Cleaning
SSPC SP 2	(2018) Hand Tool Cleaning
SSPC SP 3	(2018) Power Tool Cleaning
SSPC SP 6/NACE No.3	(2007) Commercial Blast Cleaning
SSPC SP 10/NACE No. 2	(2015) Near-White Blast Cleaning

SSPC VIS 1 (2002; E 2004) Guide and Reference
Photographs for Steel Surfaces Prepared by
Dry Abrasive Blast Cleaning

SSPC VIS 3 (2004) Guide and Reference Photographs for
Steel Surfaces Prepared by Hand and Power
Tool Cleaning

SSPC-SP WJ-3/NACE WJ-3 (2012) Thorough Cleaning, Waterjet
Cleaning of Metals

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1 (2014) Safety -- Safety and Health
Requirements Manual

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FED-STD-313 (2018) Material Safety Data,
Transportation Data and Disposal Data for
Hazardous Materials Furnished to
Government Activities

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.1000 Air Contaminants

1.3 DEFINITIONS

1.3.1 Qualification Testing

Qualification testing is the performance of all test requirements listed in the product specification. This testing is accomplished by MPI to qualify each product for the MPI Approved Product List, and may also be accomplished by Contractor's third-party testing lab if an alternative to Batch Quality Conformance Testing by MPI is desired.

1.3.2 Batch Quality Conformance Testing

Batch quality conformance testing determines that the product provided is the same as the product qualified to the appropriate product specification. This testing must be accomplished by an MPI testing lab.

1.3.3 Coating

SSPC Glossary; (1) A liquid, liquefiable, or mastic composition that is converted to a solid protective, decorative, or functional adherent film after application as a thin layer; (2) Generic term for paint, lacquer, enamel.

1.3.4 DFT or dft

Dry film thickness, the film thickness of the fully cured, dry paint or coating.

1.3.5 DSD

Degree of Surface Degradation, the MPI system of defining degree of surface degradation. Five levels are generically defined under the

Assessment sections in the **MPI MRM**, MPI Maintenance Repainting Manual.

1.3.6 EXT

MPI short term designation for an exterior coating system.

1.3.7 INT

MPI short term designation for an interior coating system.

1.3.8 Loose Paint

Paint or coating that can be removed with a dull putty knife.

1.3.9 mil / mils

The English measurement for 0.001 in or one one-thousandth of an inch.

1.3.10 MPI Gloss Levels

MPI system of defining gloss. Seven gloss levels (G1 to G7) are generically defined under the Evaluation sections of the MPI Manuals. Traditionally, Flat refers to G1/G2, Eggshell refers to G3, Semigloss refers to G5, and Gloss refers to G6.

Gloss levels are defined by MPI as follows:

Gloss Level	Description	Units at 60 degree angle	Units at 80 degree angle
G1	Matte or Flat	0 to 5	10 max
G2	Velvet	0 to 10	10 to 35
G3	Eggshell	10 to 25	10 to 35
G4	Satin	20 to 35	35 min
G5	Semi-Gloss	35 to 70	
G6	Gloss	70 to 85	
G7	High Gloss		

Gloss is tested in accordance with **ASTM D523**. Historically, the Government has used Flat (G1 / G2), Eggshell (G3), Semi-Gloss (G5), and Gloss (G6).

1.3.11 MPI System Number

The MPI coating system number in each MPI Division found in either the MPI Architectural Painting Specification Manual or the Maintenance Repainting Manual and defined as an exterior (EXT/REX) or interior system (INT/RIN).

1.3.12 Paint

SSPC Glossary; (1) Any pigmented liquid, liquefiable, or mastic composition designed for application to a substrate in a thin layer that is converted to an opaque solid film after application. Used for

protection, decoration, identification, or to serve some other functional purposes; (2) Application of a coating material.

1.3.13 REX

MPI short term designation for an exterior coating system used in repainting projects or over existing coating systems.

1.3.14 RIN

MPI short term designation for an interior coating system used in repainting projects or over existing coating systems.

1.4 SUBMITTALS

Government approval is required for submittals . Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

Samples of specified materials may be taken and tested for compliance with specification requirements.

SD-02 Shop Drawings

Piping Identification

SD-03 Product Data

Coating

Product Data Sheets

Sealant

SD-04 Samples

Color

SD-07 Certificates

Qualification Testing laboratory for coatings

Indoor Air Quality for Paints and Primers

SD-08 Manufacturer's Instructions

Application Instructions

Mixing

Manufacturer's Safety Data Sheets

SD-10 Operation and Maintenance Data

Coatings, Data Package 1

1.5 QUALITY ASSURANCE

1.5.1 Regulatory Requirements

1.5.1.1 Environmental Protection

In addition to requirements specified elsewhere for environmental protection, provide coating materials that conform to the restrictions of the local Air Pollution Control District and regional jurisdiction. Notify Contracting Officer of any paint specified herein which fails to conform.

1.5.1.2 Lead Content

Do not use coatings having a lead content over 0.06 percent by weight of nonvolatile content.

1.5.1.3 Chromate Content

Do not use coatings containing zinc-chromate or strontium-chromate.

1.5.1.4 Asbestos Content

Provide asbestos-free materials.

1.5.1.5 Mercury Content

Provide materials free of mercury or mercury compounds.

1.5.1.6 Silica

Provide abrasive blast media containing no free crystalline silica.

1.5.1.7 Human Carcinogens

Provide materials that do not contain ACGIH 0100 confirmed human carcinogens (A1) or suspected human carcinogens (A2).

1.5.1.8 Carbon Based Fibers / Tubes

Materials must not contain carbon based fibers such as carbon nanotubes or carbon nanofibers. Intelligence Bulletin 65 ranks toxicity of carbon nanotubes on a par with asbestos.

1.5.2 Coating Contractor's Qualification

Submit the name, address, telephone number, and e-mail address of the Contractor that will be performing all surface preparation and coating application. Submit evidence that key personnel have successfully performed surface preparation and application of coatings on a minimum of three similar projects within the past three years. List information by individual and include the following:

- a. Name of individual and proposed position for this work.
- b. Information about each previous assignment including:

1. Position or responsibility

2. Employer (if other than the Contractor)
3. Name of facility owner
4. Mailing address and telephone number of facility owner
5. Name of individual in facility owner's organization who can be contacted as a reference
6. Location, size and description of structure
7. Dates work was carried out
8. Description of work carried out on structure

1.5.3 Approved Products List

The current MPI, "Approved Product List" which lists paint by brand, label, product name and product code as of the date of Contract award, will be used to determine compliance with the submittal requirements of this specification. The Contractor may choose to use a subsequent MPI "Approved Product List", however, only one list may be used for the entire Contract and each coating system is to be from a single manufacturer. Provide all coats on a particular substrate from a single manufacturer. No variation from the MPI Approved Products List is acceptable.

1.5.4 Paints and Coatings Indoor Air Quality Certifications

Provide paint and coating products certified to meet indoor air quality requirements by [MPI GPS-1-14](#), [MPI GPS-2-14](#) or provide certification by other third-party programs. Provide current product certification documentation from certification body.

Provide certification of [Indoor Air Quality for Paints and Primers](#). Submit required indoor air quality certifications in one submittal package.

1.5.5 Field Samples and Tests

The Contracting Officer may choose up to two coatings that have been delivered to the site to be tested at no cost to the Government. Take samples of each chosen product as specified in the paragraph SAMPLING PROCEDURE. Test each chosen product as specified in the paragraph TESTING PROCEDURE. Remove products from the job site which do not conform, and replace with new products that conform to the referenced specification. Test replacement products that failed initial testing as specified in the paragraph TESTING PROCEDURE at no cost to the Government.

1.5.5.1 Sampling Procedure

Select paint at random from the products that have been delivered to the job site for sample testing. The Contractor must provide [one quart](#) samples of the selected paint materials. Take samples in the presence of the Contracting Officer, and label, and identify each sample. Provide labels in accordance with the paragraph PACKAGING, LABELING, AND STORAGE.

1.5.5.2 Testing Procedure

Provide Batch Quality Conformance Testing for specified products, as defined by and performed by MPI. As an alternative to Batch Quality

Conformance Testing, the Contractor may provide [Qualification Testing](#) for specified products above to the appropriate MPI product specification, using the third-party laboratory approved under the paragraph QUALIFICATION TESTING laboratory for coatings. Include the backup data and summary of the test results within the qualification testing lab report. Provide a summary listing of all the reference specification requirements and the result of each test. Clearly indicate in the summary whether the tested paint meets each test requirement. Note that Qualification Testing may take 4 to 6 weeks to perform, due to the extent of testing required.

Submit name, address, telephone number, FAX number, and e-mail address of the independent third party laboratory selected to perform testing of coating samples for compliance with specification requirements. Submit documentation that laboratory is regularly engaged in testing of paint samples for conformance with specifications, and that employees performing testing are qualified. If MPI is chosen to perform the Batch Quality Conformance testing, the above submittal information is not required, only a letter is required from the Contractor stating that MPI will perform the testing.

1.6 PACKAGING, LABELING, AND STORAGE

Provide paints in sealed containers that legibly show the Contract specification number, designation name, formula or specification number, batch number, color, quantity, date of manufacture, manufacturer's formulation number, manufacturer's directions including any warnings and special precautions, and name and address of manufacturer. Furnish pigmented paints in containers not larger than [5 gallons](#). Store paints and thinners in accordance with the manufacturer's written directions, and as a minimum, stored off the ground, under cover, with sufficient ventilation to prevent the buildup of flammable vapors, and at temperatures between [40 to 95 degrees F](#).

1.7 SAFETY AND HEALTH

Comply with applicable Federal, State, and local laws and regulations, and with the ACCIDENT PREVENTION PLAN, including the Activity Hazard Analysis as specified in Section [01 35 26](#) GOVERNMENTAL SAFETY REQUIREMENTS and in Appendix A of [EM 385-1-1](#). Include in the Activity Hazard Analysis the potential impact of painting operations on painting personnel and on others involved in and adjacent to the work zone.

1.7.1 Toxic Materials

To protect personnel from overexposure to toxic materials, conform to the most stringent guidance of:

- a. The applicable [manufacturer's Safety Data Sheets](#) (SDS) or local regulation.
- b. [29 CFR 1910.1000](#).
- c. [ACGIH 0100](#), threshold limit values.

Submit manufacturer's Safety Data Sheets for coatings, solvents, and other potentially hazardous materials, as defined in [FED-STD-313](#).

1.8 ENVIRONMENTAL REQUIREMENTS

Comply, at minimum, with manufacturer recommendations for space ventilation during and after installation. Isolate area of application from rest of building when applying high-emission paints or coatings.

1.8.1 Coatings

Do not apply coating when air or substrate conditions are:

- a. Less than 5 degrees F above dew point;
- b. Below 50 degrees F or over 95 degrees F, unless specifically pre-approved by the Contracting Officer and the product manufacturer. Do not, under any circumstances, violate the manufacturer's application recommendations.

PART 2 PRODUCTS

2.1 MATERIALS

Conform to the coating specifications and standards referenced in PART 3. Submit Product Data Sheets for specified coatings and solvents. Provide preprinted cleaning and maintenance instructions for all coating systems. Submit Manufacturer's Instructions on Mixing: Detailed mixing instructions, minimum and maximum application temperature and humidity, pot life, and curing and drying times between coats.

2.2 COLOR SELECTION OF FINISH COATS

Provide colors of finish coats as indicated or specified. Allow Contracting Officer to select colors not indicated or specified. Manufacturers' names and color identification are used for the purpose of color identification only. Named products are acceptable for use only if they conform to specified requirements. Products of other manufacturers are acceptable if the colors are approximately the colors indicated and the product conforms to specified requirements.

Provide color, texture, and pattern of wall coating systems as indicated. Submit manufacturer's samples of paint colors. Cross reference color samples to color scheme as indicated. Submit color stencil codes. Tint each coat progressively darker to enable confirmation of the number of coats.

PART 3 EXECUTION

3.1 PROTECTION OF AREAS AND SPACES NOT TO BE PAINTED

Prior to surface preparation and coating applications, remove, mask, or otherwise protect hardware, hardware accessories, machined surfaces, radiator covers, plates, lighting fixtures, public and private property, and other such items not to be coated that are in contact with surfaces to be coated. Following completion of painting, reinstall removed items by workmen skilled in the trades. Restore surfaces contaminated by coating materials, to original condition and repair damaged items.

3.2 REPUTTYING AND REGLAZING

Remove cracked, loose, and defective putty or glazing compound on glazed

sash and provide new putty or glazing compound. Where defective putty or glazing compound constitutes 30 percent or more of the putty at any one light, remove the glass and putty or glazing compound and reset the glass. Remove putty or glazing compound without damaging sash or glass. Clean rabbets to bare wood or metal and prime prior to reglazing. Provide linseed oil putty for wood sash. Patch surfaces to provide smooth transition between existing and new surfaces. Finish putty or glazing compound to a neat and true bead. Allow glazing compound time to cure, in accordance with manufacturer's recommendation, prior to coating application. Allow putty to set one week prior to coating application.

3.3 RESEALING OF EXISTING EXTERIOR JOINTS

3.3.1 Surface Condition

Begin with surfaces that are clean, dry to the touch, and free from frost and moisture; remove grease, oil, wax, lacquer, paint, defective backstop, or other foreign matter that would prevent or impair adhesion. Where adequate grooves have not been provided, clean out to a depth of 1/2 inch and grind to a minimum width of 1/4 inch without damage to adjoining work. Grinding is not required on metal surfaces.

3.3.2 Backstops

In joints more than 1/2 inch deep, install glass fiber roving or neoprene, butyl, polyurethane, or polyethylene foams free of oil or other staining elements as recommended by sealant manufacturer. Provide backstop material compatible with sealant. Do not use oakum and other types of absorptive materials as backstops.

3.3.3 Primer and Bond Breaker

Install the type recommended by the sealant manufacturer.

3.3.4 Ambient Temperature

Between 38 degrees F and 95 degrees F when applying sealant.

3.3.5 Exterior Sealant

For joints in vertical surfaces, provide ASTM C920, Type S or M, Grade NS, Class 25, Use NT. For joints in horizontal surfaces, provide ASTM C920, Type S or M, Grade P, Class 25, Use T. Color(s) will be selected by the Contracting Officer. Apply the sealant in accordance with the manufacturer's printed instructions. Force sealant into joints with sufficient pressure to fill the joints solidly. Apply sealant uniformly smooth and free of wrinkles.

3.3.6 Cleaning

Immediately remove fresh sealant from adjacent areas using a solvent recommended by the sealant manufacturer. Upon completion of sealant application, remove remaining smears and stains and leave the work in a clean condition. Allow sealant time to cure, in accordance with manufacturer's recommendations, prior to coating.

3.4 SURFACE PREPARATION

Remove dirt, splinters, loose particles, grease, oil, disintegrated

coatings, and other foreign matter and substances deleterious to coating performance as specified for each substrate before application of paint or surface treatments. Remove oil and grease prior to mechanical cleaning. Schedule cleaning so that dust and other contaminants will not fall on wet, newly painted surfaces. Spot-prime exposed ferrous metals such as nail heads on or in contact with surfaces to be painted with water-thinned paints, with a suitable corrosion-inhibitive primer capable of preventing flash rusting and compatible with the coating specified for the adjacent areas. Refer to [MPI ASM](#) and [MPI MRM](#) for additional more specific substrate preparation requirements.

3.4.1 Additional Requirements for Preparation of Surfaces With Existing Coatings

Before application of coatings, perform the following on surfaces covered by soundly-adhered coatings, defined as those which cannot be removed with a putty knife:

- a. Test existing finishes for lead before sanding, scraping, or removing. If lead is present, refer to paragraph Toxic Materials.
- b. Wipe previously painted surfaces to receive solvent-based coatings, except stucco and similarly rough surfaces clean with a clean, dry cloth saturated with mineral spirits, [ASTM D235](#) or as specified in [MPI MRM](#). Wipe the surfaces dry with a clean, dry, lint free cloth. Wipe immediately preceding the application of the first coat of any coating, unless specified otherwise.
- c. Sand existing glossy surfaces to be painted to reduce gloss. Brush, and wipe clean with a damp cloth to remove dust.
- d. The requirements specified are minimum. Comply also with the [application instructions](#) of the paint manufacturer and specific surface preparation requirements as outlined in [MPI MRM](#) Exterior Surface Preparation and Interior Surface Preparation.
- e. Thoroughly clean previously painted surfaces specified to be repainted [or](#) damaged during construction of all grease, dirt, dust or other foreign matter.
- f. Remove blistering, cracking, flaking and peeling or otherwise deteriorated coatings.
- g. Remove chalk so that when tested in accordance with [ASTM D4214](#), the chalk resistance rating is no less than 8.
- h. Roughen slick surfaces. Repair damaged areas such as, but not limited to, nail holes, cracks, chips, and spalls with suitable material to match adjacent undamaged areas.
- i. Feather and sand smooth edges of chipped paint.
- j. Clean rusty metal surfaces in accordance with SSPC requirements. Use solvent, mechanical, or chemical cleaning methods to provide surfaces suitable for painting.
- k. Provide new, proposed coatings that are compatible with existing coatings.

3.4.2 Existing Coated Surfaces with Minor Defects

Sand, spackle, and treat minor defects to render them smooth. Minor defects are defined as scratches, nicks, cracks, gouges, spalls, alligatoring, chalking, and irregularities due to partial peeling of previous coatings.

3.4.3 Removal of Existing Coatings

Remove existing coatings from the following surfaces:

- a. Surfaces containing large areas of minor defects;
- b. Surfaces containing more than 20 percent peeling area; and
- c. Surfaces designated by the Contracting Officer, such as surfaces where rust shows through existing coatings.

3.4.4 Substrate Repair

- a. Repair substrate surface damaged during coating removal;
- b. Sand edges of adjacent soundly-adhered existing coatings so they are tapered as smooth as practical to areas involved with coating removal; and
- c. Clean and prime the substrate as specified.

3.5 PREPARATION OF METAL SURFACES

3.5.1 Existing and New Ferrous Surfaces

- a. Ferrous Surfaces including Shop-coated Surfaces and Small Areas That Contain Rust, Mill Scale and Other Foreign Substances: Solvent clean in accordance with [SSPC SP 1](#) to remove oil and grease. Where shop coat is missing or damaged, clean according to [SSPC SP 2](#), . Protect shop-coated ferrous surfaces from corrosion by treating and touching up corroded areas immediately upon detection.
- b. Surfaces With More Than 20 Percent Rust, Mill Scale, and Other Foreign Substances: Clean entire surface in accordance with [SSPC SP 6/NACE No.3](#) / [SSPC-SP WJ-3/NACE WJ-3](#).

3.5.2 Final Ferrous Surface Condition:

3.5.2.1 Tool Cleaned Surfaces

Comply with [SSPC SP 2](#) and [SSPC SP 3](#). Use as a visual reference, photographs in [SSPC VIS 3](#) for the appearance of cleaned surfaces.

3.5.2.2 Abrasive Blast Cleaned Surfaces

Comply with [SSPC 7/NACE No.4](#), [SSPC SP 6/NACE No.3](#), and [SSPC SP 10/NACE No. 2](#). Use as a visual reference, photographs in [SSPC VIS 1](#) for the appearance of cleaned surfaces.

3.5.3 Galvanized Surfaces

- a. New or Existing Galvanized Surfaces With Only Dirt and Zinc Oxidation

Products: Clean with solvent, in accordance with [SSPC SP 1](#). Completely remove coating by brush-off abrasive blast if the galvanized metal has been passivated or stabilized. Do not "passivate" or "stabilize" new galvanized steel to be coated. If the absence of hexavalent stain inhibitors is not documented, test as described in [ASTM D6386](#), Appendix X2, and remove by one of the methods described therein.

- b. Galvanized with Slight Coating Deterioration or with Little or No Rusting: Water jetting to [SSPC-SP WJ-3/NACE WJ-3](#) to remove loose coating from surfaces with less than 20 percent coating deterioration and no blistering, peeling, or cracking. Use inhibitor as recommended by the coating manufacturer to prevent rusting.
- c. Galvanized With Severe Deteriorated Coating or Severe Rusting: Spot abrasive blast rusted areas as described for steel in [SSPC SP 6/NACE No.3](#), and waterjet to [SSPC-SP WJ-3/NACE WJ-3](#) to remove existing coating.

3.5.4 Non-Ferrous Metallic Surfaces

Aluminum and aluminum-alloy, lead, copper, and other nonferrous metal surfaces.

Surface Cleaning: Solvent clean in accordance with [SSPC SP 1](#) and wash with mild non-alkaline detergent to remove dirt and water soluble contaminants.

3.5.5 Existing Surfaces with a Bituminous or Mastic-Type Coating

Remove chalk, mildew, and other loose material by washing with a solution of [1/2 cup](#) trisodium phosphate, [1/4 cup](#) household detergent, [one quart](#) 5 percent sodium hypochlorite solution and [3 quarts](#) of warm water.

3.6 PREPARATION OF CONCRETE AND CEMENTITIOUS SURFACE

3.6.1 Concrete and Masonry

- a. Curing: Allow concrete, stucco and masonry surfaces to cure at least 30 days before painting, and concrete slab on grade to cure at least 90 days before painting.
- b. Surface Cleaning: Remove the following deleterious substances.
 - (1) Dirt, Chalking, Grease, and Oil: Wash new and existing uncoated surfaces with a solution composed of [1/2 cup](#) trisodium phosphate, [1/4 cup](#) household detergent, and [4 quarts](#) of warm water. Then rinse thoroughly with fresh water. For large areas, water blasting may be used.
 - (2) Fungus and Mold: Wash , existing coated, and existing uncoated surfaces with a solution composed of [1/2 cup](#) trisodium phosphate, [1/4 cup](#) household detergent, [one quart](#) 5 percent sodium hypochlorite solution and [3 quarts](#) of warm water. Rinse thoroughly with fresh water.
 - (3) Paint and Loose Particles: Remove by wire brushing.
 - (4) Efflorescence: Remove by scraping or wire brushing followed by

washing with a 5 to 10 percent by weight aqueous solution of hydrochloric (muriatic) acid. Do not allow acid to remain on the surface for more than five minutes before rinsing with fresh water. Do not acid clean more than 4 square feet of surface, per workman, at one time.

- c. Cosmetic Repair of Minor Defects: Repair or fill mortar joints and minor defects, including but not limited to spalls, in accordance with manufacturer's recommendations and prior to coating application.
- d. Allowable Moisture Content: Latex coatings may be applied to damp surfaces, but not to surfaces with droplets of water. Do not apply epoxies to damp vertical surfaces as determined by ASTM D4263 or horizontal surfaces that exceed 3 lbs of moisture per 1000 square feet in 24 hours as determined by ASTM F1869. In all cases follow manufacturer's recommendations. Allow surfaces to cure a minimum of 30 days before painting.

3.6.2 Gypsum Board, Plaster, and Stucco

3.6.2.1 Surface Cleaning

Verify that plaster and stucco surfaces are free from loose matter and that gypsum board is dry. Remove loose dirt and dust by brushing with a soft brush, rubbing with a dry cloth, or vacuum-cleaning prior to application of the first coat material. A damp cloth or sponge may be used if paint is water-based.

3.6.2.2 Repair of Minor Defects

Prior to painting, repair joints, cracks, holes, surface irregularities, and other minor defects with patching plaster or spackling compound and sand smooth.

3.6.2.3 Allowable Moisture Content

Latex coatings may be applied to damp surfaces, but not surfaces with droplets of water. Do not apply epoxies to damp surfaces as determined by ASTM D4263. Verify that new plaster to be coated has a maximum moisture content of 8 percent, when measured in accordance with ASTM D4444, Method A, unless otherwise authorized. In addition to moisture content requirements, allow new plaster to age a minimum of 30 days before preparation for painting.

3.7 PREPARATION OF WOOD AND PLYWOOD SURFACES

3.7.1 Plywood and Wood Surfaces, Except Floors:

- a. Surface Cleaning: Clean wood surfaces of foreign matter. Verify that surfaces are free from dust and other deleterious substances and in a condition approved by the Contracting Officer prior to receiving paint or other finish. Do not use water to clean uncoated wood. Scrape to remove loose coatings. Lightly sand to roughen the entire area of previously enamel-coated wood surfaces.
- b. Removal of Fungus and Mold: Wash existing coated surfaces with a solution composed of 3 ounces (2/3 cup) trisodium phosphate, one ounce (1/3 cup) household detergent, one quart 5 percent sodium hypochlorite solution and 3 quarts of warm water. Rinse thoroughly with fresh

water.

- c. Do not exceed 12 percent moisture content of the wood as measured by a moisture meter in accordance with **ASTM D4444**, Method A, unless otherwise authorized.
- d. Prime or touch up wood surfaces adjacent to surfaces to receive water-thinned paints before applying water-thinned paints.
- e. Cracks and Nailheads: Set and putty stop nailheads and putty cracks after the prime coat has dried.
- f. Cosmetic Repair of Minor Defects:
 - (1) Knots and Resinous Wood: Prior to application of coating, cover knots and stains with two or more coats of **3-pound-cut** shellac varnish, plasticized with **5 ounces** of castor oil per **gallon**. Scrape away existing coatings from knotty areas, and sand before treating. Prime before applying any putty over shellacked area.
 - (2) Open Joints and Other Openings: Fill with whiting putty, linseed oil putty. Sand smooth after putty has dried.
 - (3) Checking: Where checking of the wood is present, sand the surface, wipe and apply a coat of pigmented orange shellac. Allow to dry before paint is applied.
- g. Prime Coat For New Exterior Surfaces: Prime coat wood doors, and trim before wood becomes dirty, warped or weathered.

3.7.2 Interior Wood Surfaces, Stain Finish

Sand interior wood surfaces to receive stain. Fill oak and other open-grain wood to receive stain with a coat of wood filler not less than 8 hours before the application of stain; remove excess filler and sand the surface smooth.

3.8 APPLICATION

3.8.1 Coating Application

- a. Comply with applicable federal, state and local laws enacted to ensure compliance with Federal Clean Air Standards. Apply coating materials in accordance with **SSPC PA 1**. **SSPC PA 1** methods are applicable to all substrates, except as modified herein.
- b. At the time of application, paint must show no signs of deterioration. Maintain uniform suspension of pigments during application.
- c. Unless otherwise specified or recommended by the paint manufacturer, paint may be applied by brush, roller, or spray. Use trigger operated spray nozzles for water hoses. Use rollers for applying paints and enamels of a type designed for the coating to be applied and the surface to be coated. Wear protective clothing and respirators when applying oil-based paints or using spray equipment with any paints.
- d. Only apply paints, except water-thinned types, to surfaces that are completely free of moisture as determined by sight or touch.

- e. Thoroughly work coating materials into joints, crevices, and open spaces. Pay special attention to ensure that all edges, corners, crevices, welds, and rivets receive a film thickness equal to that of adjacent painted surfaces.
- f. Apply each coat of paint so that dry film is of uniform thickness and free from runs, drops, ridges, waves, pinholes or other voids, laps, brush marks, and variations in color, texture, and finish. Completely hide all blemishes.
- g. Touch up damaged coatings before applying subsequent coats. Broom clean and clear dust from interior areas before and during the application of coating material.
- h. Apply paint to new fire extinguishing sprinkler systems including valves, piping, conduit, hangers, supports, miscellaneous metal work, and accessories. Shield sprinkler heads with protective coverings while painting is in progress. Remove sprinkler heads which have been painted and replace with new sprinkler heads. Unfinished spaces include attic spaces, spaces above suspended ceilings, crawl spaces, pipe chases, mechanical equipment room, and space where walls or ceiling are not painted or not constructed of a prefinished material. Upon completion of painting, remove protective covering from sprinkler heads.
- i. Piping in Unfinished Areas: Provide primed surfaces with one coat of red alkyd gloss enamel (MPI 9) applied to a minimum dry film thickness of 1.0 mil in attic spaces, spaces above suspended ceilings, crawl spaces, pipe chases, mechanical equipment room, and spaces where walls or ceiling are not painted or not constructed of a prefinished material.
- j. Piping in Finished Areas: Provide primed surfaces with two coats of paint to match adjacent surfaces, except provide valves and operating accessories with one coat of red alkyd gloss enamel (MPI 9) applied to a minimum dry film thickness of 1.0 mil or two component gloss polyurethane (MPI 72) in exterior applications.
- k. Provide labeling on the surfaces of all feed and cross mains to show the pipe function such as "Sprinkler System", "Fire Department Connection", "Standpipe". For pipe sizes 4-inch and larger provide white painted stenciled letters and arrows, a minimum of 2 in in height and visible from at least two sides when viewed from the floor. For pipe sizes less than 4-inch, provide white painted stenciled letters and arrows, a minimum of 0.75 in in height and visible from the floor.
- l. All fire suppression system valves must be marked with permanent tags indicating normally open or normally closed.
- m. Drying Time: Allow time between coats, as recommended by the coating manufacturer, to permit thorough drying, but not to present topcoat adhesion problems. Provide each coat in specified condition to receive next coat.
- n. Primers, and Intermediate Coats: Do not allow primers or intermediate coats to dry more than 30 days, or longer than recommended by manufacturer, before applying subsequent coats. Follow manufacturer's

recommendations for surface preparation if primers or intermediate coats are allowed to dry longer than recommended by manufacturers of subsequent coatings. Cover each preceding coat or surface completely by ensuring visually perceptible difference in shades of successive coats.

- o. Finished Surfaces: Provide finished surfaces free from runs, drops, ridges, waves, laps, brush marks, and variations in colors.

3.8.2 Mixing and Thinning of Paints

Reduce paints to proper consistency by adding fresh paint, except when thinning is mandatory to suit surface, temperature, weather conditions, application methods, or for the type of paint being used. Obtain written permission from the Contracting Officer to use thinners. Verify that the written permission includes quantities and types of thinners to use.

When thinning is allowed, thin paints immediately prior to application with not more than **one pint** of suitable thinner per **gallon**. The use of thinner does not relieve the Contractor from obtaining complete hiding, full film thickness, or required gloss. Thinning cannot cause the paint to exceed limits on volatile organic compounds. Do not mix paints of different manufacturers.

3.8.3 Two-Component Systems

Mix two-component systems in accordance with manufacturer's instructions. Follow recommendation by the manufacturer for any thinning of the first coat to ensure proper penetration and sealing for each type of substrate.

3.8.4 Coating Systems

- a. Systems by Substrates: Apply coatings that conform to the respective specifications listed in the following Tables:

Table for Exterior Applications	
MPI Division	Substrate Application
MPI Division 3	Exterior Concrete Paint Table
MPI Division 4	Exterior Concrete Masonry Units Paint Table
MPI Division 5	Exterior Metal, Ferrous and Non-Ferrous Paint Table
MPI Division 6	Exterior Wood; Dressed Lumber, Paneling, Decking, Shingles Paint Table

Table for Interior Applications	
MPI Division	Substrate Application
MPI Division 3	Interior Concrete Paint Table

Table for Interior Applications	
MPI Division 4	Interior Concrete Masonry Units Paint Table
MPI Division 5	Interior Metal, Ferrous and Non-Ferrous Paint Table
MPI Division 6	Interior Wood Paint Table
MPI Division 9	Interior Plaster, Gypsum Board, Textured Surfaces Paint Table

- b. Minimum Dry Film Thickness (DFT): Apply paints, primers, varnishes, enamels, undercoats, and other coatings to a minimum dry film thickness of 1.5 mil each coat unless specified otherwise in the Tables. Coating thickness, where specified, refers to the minimum dry film thickness.
- c. Coatings for Surfaces Not Specified Otherwise: Coat unspecified surfaces the same as surfaces having similar conditions of exposure.
- d. Existing Surfaces Damaged During Performance of the Work, Including New Patches In Existing Surfaces: Coat surfaces with the following:
 - (1) One coat of primer.
 - (2) One coat of undercoat or intermediate coat.
 - (3) One topcoat to match adjacent surfaces.
- e. Existing Coated Surfaces To Be Painted: Apply coatings conforming to the respective specifications listed in the Tables herein, except that pretreatments, sealers and fillers need not be provided on surfaces where existing coatings are soundly adhered and in good condition. Do not omit undercoats or primers.

3.9 COATING SYSTEMS FOR METAL

Apply coatings of Tables in MPI Division 5 for Exterior and Interior.

- a. Apply specified ferrous metal primer to steel surfaces on the same day that surface is cleaned, to surfaces that meet all specified surface preparation requirements at time of application.
- b. Inaccessible Surfaces: Prior to erection, use one coat of specified primer on metal surfaces that will be inaccessible after erection.
- c. Shop-primed Surfaces: Touch up exposed substrates and damaged coatings to protect from rusting prior to applying field primer.
- d. Surface Previously Coated with Epoxy or Urethane: Apply MPI 101, 1.5 mils DFT immediately prior to application of epoxy or urethane coatings.
- e. Pipes and Tubing: The semitransparent film applied to some pipes and tubing at the mill is not to be considered a shop coat. Overcoat these items with the specified ferrous-metal primer prior to application of finish coats.

- f. Exposed Nails, Screws, Fasteners, and Miscellaneous Ferrous Surfaces. On surfaces to be coated with water thinned coatings, spot prime exposed nails and other ferrous metal with latex primer MPI 107.

3.10 COATING SYSTEMS FOR CONCRETE AND CEMENTITIOUS SUBSTRATES

Apply coatings of Tables in MPI Division 3, 4 and 9 for Exterior and Interior.

3.11 COATING SYSTEMS FOR WOOD AND PLYWOOD

- a. Apply coatings of Tables in MPI Division 6 for Exterior and Interior.
- b. Prior to erection, apply two coats of specified primer to treat and prime wood and plywood surfaces which will be inaccessible after erection.
- c. Apply stains in accordance with manufacturer's printed instructions.

3.12 PIPING IDENTIFICATION

Piping Identification, Including Surfaces In Concealed Spaces: Provide in accordance with ASME A13.1. Place stenciling in clearly visible locations. On piping not covered by ASME A13.1, stencil approved names or code letters, in letters a minimum of 1/2 inch high for piping and a minimum of 2 inches high elsewhere. Stencil arrow-shaped markings on piping to indicate direction of flow using black stencil paint.

3.13 INSPECTION AND ACCEPTANCE

In addition to meeting previously specified requirements, demonstrate mobility of moving components, including swinging and sliding doors, cabinets, and windows with operable sash, for inspection by the Contracting Officer. Perform this demonstration after appropriate curing and drying times of coatings have elapsed and prior to invoicing for final payment.

3.14 WASTE MANAGEMENT

As specified in the Waste Management Plan and as follows. Do not use kerosene or any such organic solvents to clean up water based paints. Properly dispose of paints or solvents in designated containers. Close and seal partially used containers of paint to maintain quality as necessary for reuse. Store in protected, well-ventilated, fire-safe area at moderate temperature. Place materials defined as hazardous or toxic waste in designated containers. Set aside extra paint for future color matches or reuse by the Government.

3.15 PAINT TABLES

All DFT's are minimum values. Acceptable products are listed in the MPI Green Approved Products List, available at <http://www.specifygreen.com/APL/ProductIdxByMPInum.asp>.

3.15.1 Exterior Paint Tables

3.15.1.1 MPI Division 3: Exterior Concrete Paint Table

A. Concrete; Vertical Surfaces,

(1) New and uncoated existing and Existing, previously painted concrete, elastomeric system; vertical surfaces, excluding tops of slabs

Elastomeric Coating					
New and uncoated existing	Existing, previously painted	Primer	Intermediate	Topcoat	System DFT
MPI EXT 3.1F-G1 (Flat)	MPI REX 3.1F-G1 (Flat)	Per Manufacturer	MPI 113	MPI 113	16 mils
MPI EXT 3.1F-G2/3 (Velvet)	MPI REX 3.1F-G2/3 (Velvet)	Per Manufacturer	MPI 38	MPI 38	16 mils
Primer as recommended by manufacturer. Topcoat: Coating to match adjacent surfaces. Surface preparation and number of coats in accordance with manufacturer's instructions. NOTE: Apply sufficient coats to achieve a minimum dry film thickness of 16 mils.					

3.15.1.2 MPI Division 4: Exterior Concrete Masonry Units Paint Table

A. New and Existing concrete masonry, elastomeric system; on exposed surfaces

Elastomeric Coating					
New and uncoated existing	Existing, previously painted	Primer	Intermediate	Topcoat	System DFT
MPI EXT 3.1F-G1 (Flat)	MPI REX 3.1F-G1 (Flat)	Per Manufacture	MPI 113	MPI 113	16 mils
Primer as recommended by manufacturer. Topcoat: Coating to match adjacent surfaces. Surface preparation and number of coats in accordance with manufacturer's instructions. NOTE: Apply sufficient coats of MPI 113 to achieve a minimum dry film thickness of 16 mils.					

3.15.1.3 MPI Division 5: Exterior Metal, Ferrous and Non-Ferrous Paint Table

A. Steel / Ferrous Surfaces

(1) New Steel that has been hand or power tool cleaned to SSPC SP 2 or SSPC SP 3

Alkyd					
New	Existing, uncoated	Primer	Intermediate	Topcoat	System DFT
MPI EXT 5.1Q-G5 (Semigloss)	MPI REX 5.1D-G5 (Semigloss)	MPI 23	MPI 94	MPI 94	5.25 mils
MPI EXT 5.1Q-G6 (Gloss)	MPI REX 5.1D-G6 (Gloss)	MPI 23	MPI 9	MPI 9	5.25 mils
Topcoat: Coating to match adjacent surfaces.					

(2) Existing steel that has been spot-blasted to SSPC SP 6/NACE No.3

(3) Surface previously coated with alkyd or latex

Waterborne Light Industrial Coating				
Existing, previously coated with alkyd or latex	Primer	Intermediate	Topcoat	System DFT
MPI REX 5.1C-G5 (Semigloss)	MPI 79	MPI 163	MPI 163	5 mils
MPI REX 5.1C-G6 (Gloss)	MPI 79	MPI 164	MPI 164	5 mils
Topcoat: Coating to match adjacent surfaces.				

B. Exterior Galvanized Surfaces

(1) New Galvanized surfaces

Waterborne Primer / Waterborne Light Industrial Coating				
New Galvanized Surfaces	Primer	Intermediate	Topcoat	System DFT
MPI EXT 5.3J-G5 (Semigloss)	MPI 134	MPI 163	MPI 163	4.5 mils
MPI EXT 5.3J-G6 (Gloss)	MPI 134	MPI 164	MPI 164	4.5 mils
Topcoat: Coating to match adjacent surfaces.				

(2) Galvanized surfaces with slight coating deterioration; little or no rusting

Waterborne Light Industrial Coating				
Galvanized Surfaces with slight coating deterioration	Primer	Intermediate	Topcoat	System DFT
MPI REX 5.3J-G5 (Semigloss)	MPI 134	N/A	MPI 163	4.5 mils
Topcoat: Coating to match adjacent surfaces.				

C. Exterior Surfaces, Other Metals (Non-Ferrous)

(1) Aluminum, aluminum alloy and other miscellaneous non-ferrous metal items not otherwise specified except hot metal surfaces, roof surfaces, and new prefinished equipment

Waterborne Light Industrial Coating				
New Galvanized Surfaces	Primer	Intermediate	Topcoat	System DFT
MPI EXT 5.4F-G1 (Flat)	MPI 95	MPI 161	MPI 161	5 mils
MPI EXT 5.4F-G5 (Semigloss)	MPI 95	MPI 163	MPI 163	5 mils
Topcoat: Coating to match adjacent surfaces.				

(2) Surfaces adjacent to painted surfaces; Mechanical, Electrical, and miscellaneous metal items not otherwise specified except floors, hot metal surfaces, and new prefinished equipment

Waterborne Light Industrial Coating				
New	Primer	Intermediate	Topcoat	System DFT
MPI EXT 5.1C-G3(Eggshell)	MPI 79	MPI 161	MPI 161	5 mils
MPI EXT 5.1C-G5(Semigloss)	MPI 79	MPI 163	MPI 163	5 mils
Primer as recommended by manufacturer. Topcoat: Coating to match adjacent surfaces.				

3.15.1.4 MPI Division 6: Exterior Wood; Dressed Lumber Paint Table

A. New Dressed lumber, Wood and plywood, trim, including top, bottom and edges of doors not otherwise specified

Latex					
New	Existing, uncoated	Primer	Intermediate	Topcoat	System DFT
MPI EXT 6.3A-G5 (Semigloss)	MPI EXT 6.3B-G5 (Semigloss)	MPI 5	MPI 11	MPI 11	5 mils
Topcoat: Coating to match adjacent surfaces.					

Waterborne Solid Color Stain					
New	Existing, uncoated	Primer	Intermediate	Topcoat	System DFT
MPI EXT 6.3K	MPI EXT 6.3K	MPI 5	MPI 16	MPI 16	4.25 mils
Topcoat: Coating to match adjacent surfaces.					

B. Existing, dressed lumber, Wood and plywood, trim, including top, bottom and edges of doors previously coated with a latex / waterborne finish coat not otherwise specified

Latex				
Existing, previously coated	Primer	Intermediate	Topcoat	System DFT
MPI REX 6.3L-G5 (Semigloss)	MPI 6	MPI 11	MPI 11	4.5 mils
Topcoat: Coating to match adjacent surfaces.				

Waterborne Solid Color Stain				
Existing, previously coated	Primer	Intermediate	Topcoat	System DFT
MPI EXT 6.3K	MPI 6	MPI 16	MPI 16	4 mils
Topcoat: Coating to match adjacent surfaces.				

3.15.1.5 MPI Division 9: Exterior Stucco Paint Table

A. New and Existing stucco, elastomeric system

Elastomeric Coating					
New	Existing	Primer	Intermediate	Topcoat	System DFT
MPI EXT 9.1C-G1 (Flat)	MPI REX 9.1C-G1 (Flat)	N/A	MPI 113	MPI 113	16 mils

Primer as recommended by manufacturer.
Topcoat: Coating to match adjacent surfaces. Coordinate with Section 09 24 23.
Surface preparation and number of coats in accordance with manufacturer's instructions
Apply sufficient coats of MPI 113 to achieve a minimum dry film thickness of 16 mils.

3.15.2 Interior Paint Tables

3.15.2.1 MPI Division 4: Interior Concrete Masonry Units Paint Table

A. New and uncoated Existing Concrete Masonry

High Performance Architectural Latex					
New, uncoated Existing	Filler	Primer	Intermediate	Topcoat	System DFT
MPI INT 4.2D-G5 (Semigloss)	MPI 4	N/A	MPI 141	MPI 141	11 mils
Fill all holes in masonry surface					

B. Existing, Previously Painted Concrete Masonry

High Performance Architectural Latex					
Existing, previously painted	Filler	Primer	Intermediate	Topcoat	System DFT
MPI RIN 4.2K-G5 (Semigloss)	N/A	MPI 141	MPI 141	MPI 141	4.5 mils

3.15.2.2 MPI Division 5: Interior Metal, Ferrous and Non-Ferrous Paint Table

A. Interior Steel / Ferrous Surfaces

(1) Metal, Mechanical, Electrical, Fire extinguishing sprinkler systems including valves, conduit, hangers, supports, Surfaces adjacent to painted surfaces (Match surrounding finish), exposed copper piping, and miscellaneous metal items not otherwise specified except floors, hot metal surfaces, items subject to traffic and new prefinished equipment

High Performance Architectural Latex				
New, uncoated Existing	Primer	Intermediate	Topcoat	System DFT
MPI INT 5.1R-G5 (Semigloss)	MPI 76	MPI 141	MPI 141	5 mils

Topcoat: Coating to match adjacent surfaces.

(2) Metal subject to traffic (Hatches) with non-skid additive (NSA), load at manufacturer's recommendations

Alkyd (over q.d. Alkyd Primer)				
New, uncoated Existing	Primer	Intermediate	Topcoat	System DFT
MPI INT 5.1E-G5 (Semi-Gloss)	MPI 76	MPI 47	MPI 47	5.25 mils
Topcoat: Coating to match adjacent surfaces.				

(3) Miscellaneous non-ferrous metal items not otherwise specified except floors, hot metal surfaces, and new prefinished equipment. Match surrounding finish

High Performance Architectural Latex				
New, uncoated Existing	Primer	Intermediate	Topcoat	System DFT
MPI INT 5.4F-G5 (Semigloss)	MPI 95	MPI 141	MPI 141	5 mils
Topcoat: Coating to match adjacent surfaces.				

B. Hot Surfaces

(1) Hot metal surfaces including smokestacks subject to temperatures up to 400 degrees F

Heat Resistant Enamel				
New	N/A	Intermediate	Topcoat	System DFT
MPI INT 5.2A	MPI 21	N/A	N/A	Per Manufacturer
Surface preparation and number of coats per manufacturer's instructions.				

3.15.2.3 MPI Division 6: Interior Wood Paint Table

A. Interior Wood and Plywood

(1) New and Existing, uncoated Wood and plywood not otherwise specified

High Performance Architectural Latex				
New, uncoated Existing	Primer	Intermediate	Topcoat	System DFT
MPI INT 6.4S-G3 (Eggshell)	MPI 39	MPI 139	MPI 139	4.5 mils
Topcoat: Coating to match adjacent surfaces.				

(2) Wood Trim and Doors not otherwise specified

High Performance Architectural Latex				
Existing, previously painted	Primer	Intermediate	Topcoat	System DFT
MPI RIN 6.4B-G5 (Semigloss)	MPI 39	MPI 141	MPI 141	4.5 mils
Topcoat: Coating to match adjacent surfaces.				

B. Interior New Wood and Plywood, except floors; natural finish or stained

Stained, oil-modified polyurethane						
New	Existing	Stain	Primer	Intermediate	Topcoat	System DFT
MPI INT 6.4E-G4	MPI RIN 6.4G-G4	MPI 90	MPI 57	MPI 57	MPI 57	4 mils
MPI INT 6.4E-G6 (Gloss)	MPI RIN 6.4G-G6 (Gloss)	MPI 90	MPI 56	MPI 56	MPI 56	4 mils

3.15.2.4 MPI Division 9: Interior Plaster, Gypsum Board, Paint Table

A. Interior New and Existing, previously painted Wallboard not otherwise specified

Latex					
New	Existing, previously painted	Primer	Intermediate	Topcoat	System DFT
MPI INT 9.2A-G3 (Eggshell)	RIN 9.2A-G3 (Eggshell)	MPI 50	MPI 52	MPI 52	4 mils
Topcoat: Coating to match adjacent surfaces.					

High Performance Architectural Latex - High Traffic Areas

New	Existing, previously painted	Primer	Intermediate	Topcoat	System DFT
MPI INT 9.2B-G3 (Eggshell)	MPI RIN 9.2B-G3 (Eggshell)	MPI 50	MPI 139	MPI 139	4 mils
Topcoat: Coating to match adjacent surfaces.					

Institutional Low Odor / Low VOC Latex, New

Institutional Low Odor / Low VOC Latex				
New	Primer	Intermediate	Topcoat	System DFT
MPI INT 9.2M-G3 (Eggshell)	MPI 149	MPI 145	MPI 145	4 mils
Topcoat: Coating to match adjacent surfaces.				

Institutional Low Odor / Low VOC Latex, Existing, previously painted

Institutional Low Odor / Low VOC Latex				
Existing, previously painted	Primer	Intermediate	Topcoat	System DFT
MPI RIN 9.2M-G3 (Eggshell)	MPI 144	MPI 145	MPI 145	4 mils
Topcoat: Coating to match adjacent surfaces.				

B. Interior New and Existing, previously painted Wallboard in toilets, food-preparation, food-serving, areas requiring a high degree of sanitation, and other high humidity areas not otherwise specified

Waterborne Light Industrial Coating					
New, uncoated Existing	Existing, previously painted	Primer	Intermediate	Topcoat	System DFT
MPI INT 9.2L-G5(Semigloss)	MPI RIN 9.2L-G5 (Semigloss)	MPI 50	MPI 153	MPI 153	4 mils
Topcoat: Coating to match adjacent surfaces.					

-- End of Section --

SECTION 10 14 00.10

EXTERIOR SIGNAGE
08/17, CHG 1: 11/18

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ALUMINUM ASSOCIATION (AA)

AA DAF45 (2003; Reaffirmed 2009) Designation System
for Aluminum Finishes

AMERICAN WELDING SOCIETY (AWS)

AWS C1.1M/C1.1 (2012) Recommended Practices for
Resistance Welding

AWS D1.1/D1.1M (2020; Errata 1 2021) Structural Welding
Code - Steel

ASTM INTERNATIONAL (ASTM)

ASTM A123/A123M (2017) Standard Specification for Zinc
(Hot-Dip Galvanized) Coatings on Iron and
Steel Products

ASTM A653/A653M (2022) Standard Specification for Steel
Sheet, Zinc-Coated (Galvanized) or
Zinc-Iron Alloy-Coated (Galvannealed) by
the Hot-Dip Process

ASTM A924/A924M (2022a) Standard Specification for General
Requirements for Steel Sheet,
Metallic-Coated by the Hot-Dip Process

ASTM B26/B26M (2018; E 2018) Standard Specification for
Aluminum-Alloy Sand Castings

ASTM B108/B108M (2019) Standard Specification for
Aluminum-Alloy Permanent Mold Castings

ASTM B209 (2014) Standard Specification for Aluminum
and Aluminum-Alloy Sheet and Plate

ASTM B221 (2021) Standard Specification for Aluminum
and Aluminum-Alloy Extruded Bars, Rods,
Wire, Profiles, and Tubes

NATIONAL ASSOCIATION OF ARCHITECTURAL METAL MANUFACTURERS (NAAMM)

NAAMM AMP 500 (2006) Metal Finishes Manual

1.2 GENERAL REQUIREMENTS

All exterior signage must be provided by a single manufacturer. Exterior signage must be of the design, detail, sizes, types, and message content shown on the drawings, must conform to the requirements specified, and must be provided at the locations indicated. Submit exterior signage schedule in electronic media with spread sheet format. Spread sheet must include sign location, sign type, and message. Signs must be complete with lettering, framing as detailed, and related components for a complete installation. Each sample must consist of a complete sign panel with letters and symbols. Samples may be installed in the work, provided each sample is identified and location recorded. Submit three color samples for each material requiring color and 12 inch square sample of sign face color sample.

1.2.1 Wind Load Requirements

Exterior signage must be designed to withstand 20 mph windload. Submit design analysis and supporting calculations performed in support of specified signage.

1.2.2 Character Proportions and Heights

Letters and numbers on indicated signs for handicapped-accessible buildings must have a width-to-height ratio between 3:5 and 1:1 and a stroke-width-to-height ratio between 1:5 and 1:10. Characters and numbers on indicated signs must be sized according to the viewing distance from which they are to be read. The minimum height is measured using an upper case letter "X". Lower case characters are permitted.

1.3 SUBMITTALS

Government approval is required for submittals . Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Approved Detail Drawings

SD-03 Product Data

Installation

Exterior Signage

Wind Load Requirements

SD-04 Samples

Exterior Signage

SD-10 Operation and Maintenance Data

Protection and Cleaning

1.4 QUALIFICATIONS

Signs, and dimensional letters must be the standard product of a manufacturer regularly engaged in the manufacture of the products. Items

of equipment must essentially duplicate equipment that has been in satisfactory use at least 2 years prior to bid opening.

1.5 DELIVERY AND STORAGE

Materials must be wrapped for shipment and storage, delivered to the jobsite in manufacturer's original packaging, and stored in a clean, dry area in accordance with manufacturer's instructions.

1.6 WARRANTY

Manufacturer's standard performance guarantees or warranties that extend beyond a one year period must be provided.

PART 2 PRODUCTS

2.1 GRAPHICS FOR EXTERIOR SIGNAGE SYSTEMS

Reflective type aluminum for FDC Connection. FDC sign shall be blind mounted to building exterior wall at heights as indicated on accessibility sheets. Color shall be red with white lettering and boarder.

2.2 DIMENSIONAL BUILDING LETTERS

2.2.1 Fabrication

Letters must be fabricated from 0.125 inch aluminum sheet. Letters must be cleaned by chemical etching or cleaned ultrasonically in a special degreasing bath. Letters must be packaged for protection until installation.

2.2.2 Typeface

Typeface must be as indicated.

2.2.3 Size

Letter size must be as indicated.

2.2.4 Finish

Polished clear anodized aluminum finish must be provided.

2.2.5 Mounting

Threaded studs of number and size as recommended by manufacturer, must be used for concealed anchorage. Letters which project from the building line must have stud spacer sleeves. Letters, studs, and sleeves must be of the same material. Supply templates for mounting.

2.3 ALUMINUM ALLOY PRODUCTS

Aluminum alloy products must conform to ASTM B209 for sheet or plate, ASTM B221 for extrusions and ASTM B26/B26M or ASTM B108/B108M for castings. Aluminum extrusions must be provided at least 1/8 inch thick and aluminum plate or sheet at least 16 gauge thick. Welding for aluminum products must conform to AWS C1.1M/C1.1.

2.4 ANODIC COATING

Anodized finish must conform to AA DAF45 as follows:

Clear (natural) designation AA-M10-C22-A31, Architectural Class II 0.4 mil or thicker.

2.5 ORGANIC COATING

Clean, prime and give surfaces a two-component acrylic polyurethane finish in accordance with NAAMM AMP 500, AMP 505, with total dry film thickness not less than 1.2 mils.

2.6 ANCHORS AND FASTENERS

Exposed anchor and fastener materials must be compatible with metal to which applied and must match in color and finish and must be non-rusting, non-corroding, and non-staining. Exposed fasteners must be tamper-proof.

2.7 SHOP FABRICATION AND MANUFACTURE

2.7.1 Factory Workmanship

Work must be assembled in the shop, as far as practical, ready for installation at the site. Work that cannot be shop assembled must be given a trial fit in the shop to ensure proper field assembly. Holes for bolts and screws must be drilled or punched. Drilling and punching must produce clean, true lines and surfaces. Welding to or on structural steel must be in accordance with AWS D1.1/D1.1M. Welding must be continuous along the entire area of contact. Exposed welds must be ground smooth. Exposed surfaces of work must have a smooth finish and exposed riveting must be flush. Fastenings must be concealed where practical. Items specified to be galvanized must be by hot-dip process after fabrication if practical. Galvanization must be in accordance with ASTM A123/A123M and ASTM A653/A653M, as applicable. Other metallic coatings of steel sheet must be in accordance with ASTM A924/A924M. Joints exposed to the weather must be formed to exclude water. Drainage and weep holes must be included as required to prevent condensation buildup.

2.7.2 Dissimilar Materials

Where dissimilar metals are in contact, or where aluminum is in contact with concrete, mortar, masonry, wet or pressure-treated wood, or absorptive materials subject to wetting, the surfaces must be protected with a coat of asphalt varnish or a coat of zinc-molybdate primer to prevent galvanic or corrosive action.

2.7.3 Shop Painting

Surfaces of miscellaneous metal work, except nonferrous metal, corrosion resisting steel, and zinc-coated work, must be given one coat of zinc-molybdate primer or an approved rust-resisting treatment and metallic primer in accordance with manufacturer's standard practice. Surfaces of items to be embedded in concrete must not be painted. Upon completion of work, damaged surfaces must be recoated.

2.8 COLOR, FINISH, AND CONTRAST

Color must be as indicated. Color listed is not intended to limit the

selection of equal colors from other manufacturers. For buildings required to be handicapped-accessible, the characters and background of signs must be eggshell, matte, or other non-glare finish. Characters and symbols must contrast with their background - either light characters on a dark background or dark characters on a light background.

PART 3 EXECUTION

3.1 INSTALLATION

Signs, or dimensional letters must be installed in accordance with approved manufacturer's instructions at locations shown on the [approved detail drawings](#); submit drawings showing elevations of each type of sign; dimensions, details, and methods of mounting or anchoring; shape and thickness of materials; and details of construction. A schedule showing the location, each sign type, and message must be included. Signs must be installed plumb and true at mounting heights indicated, and by method shown or specified. Signs mounted on other surfaces must not be installed until finishes on such surfaces have been completed. Submit manufacturer's installation instructions and cleaning instructions.

3.1.1 Anchorage

Anchorage and fastener materials must be in accordance with approved manufacturer's instructions for the indicated substrate. Anchorage not otherwise specified or indicated must include slotted inserts, expansion shields, and powder-driven fasteners when approved for concrete; toggle bolts and through bolts for masonry; machine carriage bolts for steel; lag bolts and screws for wood.

3.1.2 [Protection and Cleaning](#)

The work must be protected against damage during construction. Hardware must be adjusted for proper operation. [Sign](#) surfaces must be cleaned in accordance with manufacturer's instructions. After signs are completed and inspected, cover all project identification, directional, and other signs which may mislead the public. Covering must be maintained until instructed to be removed by the Contracting Officer or until the facility is to be opened for business. Submit six copies of maintenance instructions listing routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guides. The instructions must include simplified diagrams for the equipment as installed. Signs must be cleaned, as required, at time of cover removal.

-- End of Section --

SECTION 10 14 00.20

INTERIOR SIGNAGE
08/20

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

INTERNATIONAL CODE COUNCIL (ICC)

ICC/ANSI A117.1 (2009) Accessible and Usable Buildings and Facilities

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI/NEMA LD 3 (2005) Standard for High-Pressure Decorative Laminates

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 101 (2021; TIA 21-1) Life Safety Code

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

36 CFR 1191 Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines

1.2 SUBMITTALS

Government approval is required for submittals. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Detail Drawings

SD-03 Product Data

Room Identification And Directional Signage System

Exit Door Tactile Sign

SD-04 Samples

Interior Signage

Room Identification And Directional Signage System

Exit Door Tactile Sign

SD-10 Operation and Maintenance Data

Approved Manufacturer's Instructions

Protection and Cleaning

1.3 QUALITY ASSURANCE

1.3.1 Samples

Submit **interior signage** samples of each of the following sign types showing typical quality, workmanship and color: all sign types included in project. Approved samples may be installed in the work, provided each sample is identified and location recorded.

1.3.2 Detail Drawings

Submit detail drawings showing elevations of each type of sign, dimensions, details and methods of mounting or anchoring, mounting height, shape and thickness of materials, and details of construction. Include a schedule showing the location, each sign type, and message.

1.3.3 Sign Fabricator

Sign Fabricator to follow room number strategies created by designer. The room numbering system to be reviewed and approved by the Contracting Officer and command end users during the shop drawing phase, and prior to fabrication.

1.4 DELIVERY, STORAGE, AND HANDLING

Package materials to prevent damage and deterioration during shipment, handling, storage and installation. Deliver products to the jobsite in manufacturer's original packaging and store in a clean, dry area in accordance with manufacturer's instructions.

1.5 WARRANTY

Provide manufacturer's warranty to repair or replace defective interior signage materials and workmanship for a period of 2 years from date of final acceptance of the work.

PART 2 PRODUCTS

2.1 ROOM IDENTIFICATION AND DIRECTIONAL SIGNAGE SYSTEM

Provide signs, and dimensional building letters that are standard products of manufacturers regularly engaged in the manufacture of such products that essentially duplicate signs that have been in satisfactory use at least 2 years prior to bid opening. Obtain signage from a single manufacturer with edges and corners of finished letter forms and graphics true and clean.

2.1.1 Room Number Signs (NO)

Gemini, Take Form, or Best meeting accessible requirements. Typical plaques to be 8 inch x 8 inch with 3/4 inch radius corners, frameless with wording and Braille mechanically etched into 1/16 inch etchable, durable, water-soluble polymer, adhesive laminated to 1/8 inch photo polymer.

Raised letters shall be positioned upper left and shall be painted, sans serif, upper case, 5/8 inch high unless otherwise scheduled, color of background and letters to be as selected. Both Braille and letters shall be raised 1/32 inch from background, prepared for silastic adhesive mounting 5 feet above floor to the wall on the lock side of the door. For mounting on glass, provide a finished blank on the room side of the glazing matching the size of the scheduled sign. Furnish in quantities and with wording as scheduled. Mounting heights for signage shall be per accessibility requirements.

2.1.2 Name Signs (NA)

Similar to Room Number Signs except plaques shall be a minimum of 8 inch high x length as required for wording plus 2 inch margin at ends. Provide multi-line signs to achieve proper proportions.

2.1.3 Insert Signs (IN)

Similar to Room Number Sign except add removable insert with 1/4 inch high letters. Plaques shall be minimum 8 inch high x length as required for wording plus 2 inch margin at ends. If insert lettering is not scheduled, assume 15 characters to be determined when submittals are reviewed. Provide multi-line signs and multi-line inserts to achieve proper proportions.

2.1.4 Graphic Signs (GF)

Similar to Room Number sign except size shall be a minimum of 11 inch high (6 inch pictogram field with text below per accessibility requirements) x 8 inch wide minimum. Signs shall include international pictograms for handicapped, male and/or female figure.

2.1.5 Character Proportions and Heights

Letters and numbers on signs conform to 36 CFR 1191.

2.2 EXIT DOOR TACTILE SIGN

Provide tactile sign with the message EXIT at each exit door that requires an exit sign to conform with NFPA 101. Sign tactile message is to comply with ICC/ANSI A117.1.

2.3 MATERIALS

2.3.1 Plastic Laminate Sheet

ANSI/NEMA LD 3, general purpose HGS grade, 0.048 inch nominal thickness.

2.3.2 Fabrication and Manufacture

2.3.2.1 Factory Workmanship

Holes for bolts and screws are drilled or punched. Drilling and punching produces clean, true lines and surfaces. Exposed surfaces of work have a smooth finish; exposed riveting is flush. Conceal fastenings where practicable.

2.4 COLOR, FINISH, AND CONTRAST

Provide color as selected from manufacturer's standard colors. Finish of eggshell, matte, or other non-glare finish for all signs as required in handicapped-accessible buildings.

PART 3 EXECUTION

3.1 PLACEMENT SCHEDULE

LOCATION	WORDING	TYPE
	(To be provided by Owner unless otherwise noted)	
OFFICE 107	107	NO/IN
OFFICE 109	109	NO/IN
MENS 102	MENS (w/ HC SYMBOL)	GF
WOMENS 104	WOMENS (w/ HC SYMBOL)	GF
FAMILY 105	RESTROOM (w/ HC SYMBOL)	GF
MEN 119	MENS (w/ HC SYMBOL)	GF
WOMEN 118	WOMENS (w/ HC SYMBOL)	GF
ALL KITCHEN AREAS AND SERVING LINE HAND WASHING SINKS	ALL EMPLOYEES MUST WASH HANDS	NA
OFFICE 122	122	NO/IN
OFFICE 123	123	NO/IN
JANITOR 135	JANITOR	NO/NA
JANITOR 136	JANITOR	NO/NA
PRODUCE COOLER 124	PRODUCE COOLER	NA
DAIRY/COOKS COOLER 124A	DAIRY/COOKS COOLER	NA
THAW COOLER 124B	THAW COOLER	NA
FREEZER 126	FREEZER	NA
DRY STORAGE 128	DRY STORAGE 128	NO/NA
SODA ROOM 127	SODA ROOM 127	NO/NA
COMM ROOM C-1	COMMUNICATIONS	NA
FIRE SPRINKLER ROOM 137	FIRE SPRINKLER	NA
FDC CONNECTION	FDC	NA/MT

3.2 INSTALLATION

Install signs plumb and true and in accordance with approved manufacturer's instructions at locations shown on the schedule above. Mounting height and mounting location complies with 36 CFR 1191. Install required blocking. Do not install signs on doors or other surfaces until finishes on such surfaces have been installed. Signs installed on glass surfaces are installed with matching blank back-up plates in accordance with manufacturer's instructions.

Do not install items that show visual evidence of biological growth.

3.2.1 Anchorage

Provide anchorage in accordance with approved manufacturer's instructions. Anchorage not otherwise specified or shown includes slotted inserts, expansion shields, and powder-driven fasteners when approved for concrete; toggle bolts and through bolts for masonry; machine carriage bolts for steel; lag bolts and screws for wood. Provide exposed anchor and fastener materials compatible with metal to which applied with matching color and finish.

- a. Signs mounted to painted gypsum board surfaces must be removable for

painting maintenance.

- b. Install signs mounted on metal surfaces with magnetic tape.

3.2.2 Protection and Cleaning

Protect the work against damage during construction. Adjust hardware and electrical equipment for proper operation. Clean glass, frames, and other sign surfaces at completion of signage installation in accordance with the manufacturer's written instructions.

-- End of Section --

SECTION 10 21 13

TOILET COMPARTMENTS
08/20

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ALUMINUM ASSOCIATION (AA)

AA DAF45 (2003; Reaffirmed 2009) Designation System
for Aluminum Finishes

ASTM INTERNATIONAL (ASTM)

ASTM A123/A123M (2017) Standard Specification for Zinc
(Hot-Dip Galvanized) Coatings on Iron and
Steel Products

ASTM A167 (2011) Standard Specification for
Stainless and Heat-Resisting
Chromium-Nickel Steel Plate, Sheet, and
Strip

ASTM A385/A385M (2022) Standard Practice for Providing
High-Quality Zinc Coatings (Hot-Dip)

ASTM B221 (2021) Standard Specification for Aluminum
and Aluminum-Alloy Extruded Bars, Rods,
Wire, Profiles, and Tubes

INTERNATIONAL CODE COUNCIL (ICC)

ICC A117.1 (2017) Standard And Commentary Accessible
and Usable Buildings and Facilities

SCIENTIFIC CERTIFICATION SYSTEMS (SCS)

SCS SCS Global Services (SCS) Indoor Advantage

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

CID A-A-60003 (Basic; Notice 1) Partitions, Toilet,
Complete

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

36 CFR 1191 Americans with Disabilities Act (ADA)
Accessibility Guidelines for Buildings and
Facilities; Architectural Barriers Act
(ABA) Accessibility Guidelines

UNDERWRITERS LABORATORIES (UL)

UL 2818

(2013) GREENGUARD Certification Program
For Chemical Emissions For Building
Materials, Finishes And Furnishings

1.2 SUBMITTALS

Government approval is required for submittals. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Fabrication Drawings

Installation Drawings

SD-03 Product Data

Cleaning and Maintenance Instructions

Colors And Finishes

Anchoring Devices and Fasteners

Hardware and Fittings

Brackets

Door Hardware

Pilaster Shoes

Finishes

SD-04 Samples

Colors and Finishes

Hardware and Fittings

Anchoring Devices and Fasteners

SD-07 Certificates

Warranty

1.3 CERTIFICATIONS

1.3.1 Indoor Air Quality

1.3.1.1 Solid Phenolic Products

Provide products certified to meet indoor air quality requirements by UL 2818 (Greenguard) Gold, SCS Global Services Indoor Advantage Gold or provide certification or validation by other third-party program that products meet the requirements of this Section. Provide current product certification documentation from certification body.

1.4 REGULATORY REQUIREMENTS

Comply with to [ICC A117.1](#) code for access for the handicapped operation of toilet compartment door and hardware.

1.5 DELIVERY, STORAGE, AND HANDLING

Deliver materials in the manufacturer's original unopened packages with the brand, item identification, and project reference clearly marked. Store components in a dry location that is adequately ventilated; free from dust, water, other contaminants, and damage during delivery, storage, and construction.

1.6 WARRANTY

Provide manufacturer's warranty to repair or replace defective materials and workmanship for a period of [25](#) years from date of final acceptance of the work.

PART 2 PRODUCTS

2.1 SYSTEM REQUIREMENTS

Provide a complete and usable toilet partition system, including toilet enclosures, urinal screens, hardware, and support components. Furnish the partition system from a single manufacturer, with a standard product as shown in the most recent catalog data. Submit [Fabrication Drawings](#) for toilet partitions and urinal screens consisting of fabrication and assembly details to be performed in the factory. Submit manufacturer's [Cleaning and Maintenance Instructions](#) in accordance with Section [01 78 23](#) OPERATIONS AND MAINTENANCE DATA.

2.2 MATERIALS

2.2.1 Solid Polyethylene Panels (Finish 5)

Provide high density polyethylene (HDPE) suitable for exposed application. Waterproof, non-absorbent and graffiti resistant textured surface with a Flame Spread Index of 75 or less, and a Smoke Developed Index of 450 or less.

2.2.2 [Anchoring Devices and Fasteners](#)

Provide steel anchoring devices and fasteners hot-dipped galvanized after fabrication, in conformance with [ASTM A385/A385M](#) and [ASTM A123/A123M](#). Conceal all galvanized anchoring devices.

2.2.3 [Brackets](#)

Provide two-ear panel wall brackets, T-style, [1 inch](#) stock. Provide stirrup style panel-to-pilaster brackets.

2.2.4 [Hardware and Fittings](#)

2.2.4.1 General Requirements

Provide hardware for the toilet partition system that complies with [CID A-A-60003](#) for the specified type and style of partitions. Provide hardware finish highly resistant to alkalis, urine, and other common

toilet room acids. Comply with 36 CFR 1191 of latching devices and hinges for handicap compartments; provide stainless steel devices and hinges with door latches that operate without either tight grasping or twisting of the wrist of the operator. Submit three samples of each item, including anchoring devices and fasteners. Approved hardware samples may be installed in the work if properly identified.

Material	Conformance Standard
Aluminum	ASTM B221
Corrosion-resistant steel	ASTM A167, Type 304

2.2.4.2 Finishes

- a. Provide stainless steel with a No. 4 finish.
- b. Provide exposed fasteners that match the hardware and fittings.

2.2.5 Door Hardware

2.2.5.1 Hinges

Provide adjustable hinges to hold in-swinging doors open at any angle up to 90 degrees and outswinging doors up to 10 degrees. Provide self-lubricating hinges with the indicated swing. Provide hinges that continuous stainless steel with spring loaded return movement:

2.2.5.2 Latch and Pull

- A. Door Strike/Keeper: Heavy-duty extruded aluminum 6436-T5 alloy with a bright dip anodized finish. Secured to pilasters with stainless steel tamper resistant Torx head sex bolts. Bumper shall be made of extruded black vinyl.
 1. Style: 3 inches (76 mm) stainless steel emergency access.
- B. Latch Mechanism: Occupancy Indicator Latch and Housing:
 1. Material: Satin stainless steel.
 2. Occupancy indicators: Green for occupied and red not occupied.
 3. Slide bolt and button
- C. Door Pull: Heavy-duty extruded aluminum 6436-T5 alloy with a bright dip anodized finish. Equip outswing handicapped doors with second door pull and door stop

2.2.5.3 Coat Hooks

Provide coat hooks that are combination units with hooks and rubber tipped pins.

2.3 PARTITION PANELS AND DOORS

Fabricate partition panels, and pilasters of materials and construction listed:

Provide . plastic (HDPE) partition panels, doors and pilasters not less than 1 inch thick .

Provide solid polyethylene toilet partitions and screens with recycled content of 30 percent minimum.. . Provide solid phenolic toilet partitions and screens with recycled content of 10 percent minimum.

2.3.1 Toilet Enclosures

Provide toilet enclosures that comply with CID A-A-60003, Type I, Style C, overhead braced . Furnish width, length, and height of toilet enclosures as shown. Finish surface of panels are solid polyethylene (Finish 5); water resistant; graffiti resistant; non-absorbent radius beveled edges. Reinforce panels indicated to receive toilet paper holders or grab bars for mounting of the items required, and provide cut outs for through partition toilet accessories. Provide grab bars to withstand a bending stress, shear stress, shear force, and a tensile force induced by 250 lbf. Grab bars cannot rotate within their fittings.

2.3.2 Room Entrance Screens

Provide room entrance screens that comply with CID A-A-60003, Type II, Style C, overhead braced . Provide finish surface of screens to be solid polyethylene (Finish 5); water resistant; graffiti resistant; non-absorbent with radius beveled edges. Furnish length and height of screens as shown. Provide thickness to match toilet compartment panel construction. Fabricate screens from the same types of panels, pilasters, and fittings as the toilet partitions.

2.3.3 Urinal Screens

Provide urinal screens that comply with CID A-A-60003, Type III, Style C, overhead braced . Provide finish for surface of screens as solid polyethylene (Finish 5) ; water resistant; graffiti resistant; non-absorbent with radius beveled edges; with manufacturer's standard post design of materials matching the thickness and construction of pilasters. Furnish width and height of urinal screens as shown. Provide thickness to match toilet compartment panel construction. Secure wall hung urinal screens with 42 inches long, continuous flanges. Fabricate screens from the same types of panels and pilasters as the toilet partitions. Use corrosion-resistant steel fittings and fasteners.

2.4 CEILING-HUNG PARTITIONS

Provide pilasters in size indicated that are manufacturer's standard corrosion resistant anchoring assemblies complete with leveling adjustment nuts at pilasters for connection to structural support above finished ceiling. Design anchoring device to transmit the strain and loading on the pilaster directly to the structural support above without putting strain or loading on the finished ceiling. Provide sleeves or caps at tops of pilasters to conceal anchorage.

2.5 FLOOR-ANCHORED PARTITIONS

Provide pilasters in size indicated that are manufacturer's standard corrosion resistant anchoring assemblies complete with leveling adjustment nuts and pilasters for structural connection to floor. Provide anchoring device at the bottom of the pilaster consisting of a steel bar not less

than 1/2 by 7/8 inch welded to the reinforced face sheets and having not less than two 3/8 inch round anchorage devices for securing to the floor slab. Provide anchorage devices complete with threaded rods, expansion shields, lock washers, and leveling-adjustment nuts. Provide shoes at pilasters to conceal anchorage.

2.6 OVERHEAD-BRACED PARTITIONS

Provide pilasters in sizes indicated that are manufacturer's standard corrosion-resistant supports, leveling mechanism, and anchors at pilasters to suit floor conditions. Provide shoes at pilasters to conceal supports and leveling mechanism. Provide anchoring device at the bottom of the pilaster consisting of a channel-shaped floor stirrup fabricated from not less than 0.0635 inch thick material and a leveling bolt. Secure the stirrup to the pilaster with not less than a 3/16 inch bolt and nut after the pilaster is leveled. Secure the stirrup to the floor with not less than two lead expansion shields and sheetmetal screws. Fabricate overhead brace from a continuous extruded aluminum tube not less than 1 inch wide by 1-1/2 inch high, 0.125 inch wall thickness. Finish is AA-C22A31 in accordance with AA DAF45. Set and secure brace into the top of each pilaster. Provide shoes at pilasters to conceal supports and leveling mechanism.

2.7 PILASTER SHOES

Provide shoes at pilasters to conceal floor-mounted anchorage. Provide stainless steel pilaster shoes. Height is a minimum 3 inches.

2.8 HARDWARE

Provide hardware for the toilet partition system that complies with CID A-A-60003 for the specified type and style of partitions. Provide hardware pre-drilled by manufacturer. Use a hardware finish that is highly resistant to alkalis, urine, and other common toilet room acids. Provide latching devices and hinges for handicap compartments complying with 36 CFR 1191 and stainless steel door latches that operate without either tight grasping or twisting of the wrist of the operator. Use stainless steel, tamper proof type screws and bolts. Wall mounting brackets are continuous, full height, stainless steel, in accordance with toilet compartment manufacturer's instructions.. Provide floor-mounted anchorage consisting of corrosion-resistant anchoring assemblies with threaded rods, lock washers, and leveling adjustment nuts at pilasters for structural connection to floor.

2.9 COLORS AND FINISHES

2.9.1 Colors

Provide color as indicated; colors listed are not intended to limit the selection of equal colors from other manufacturers.

Submit three samples showing color and a finished edge on two adjacent sides and core construction, each not less than 12 inch square.

2.9.2 Finishes

2.9.2.1 Finishes No. 4, No 4A and No. 5

Provide manufacturer's standard solid polyethylene (Finish 5) formed under

high pressure rendering a single component section not less than 1 inch thick. Colors extend throughout the panel thickness.

PART 3 EXECUTION

3.1 PREPARATION

Take field measurements prior to the preparation of drawing and fabrication to ensure proper fits. Verify that field measurements, surfaces, substrates and conditions are as required, and ready to receive work. Verify correct spacing of plumbing fixtures. Verify correct location of built in framing, anchorage, and bracing. Report in writing to Contracting Officer prevailing conditions that adversely affect satisfactory execution of the work of this section. Do not proceed with work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

Do not install items that show visual evidence of biological growth. Install partitions rigid, straight, plumb, and level, with the panels centered between the fixtures. Provide a panel clearance of not more than 1/2 inch and secure the panels to walls and pilasters with continuous full height wall brackets. Locate wall brackets so that holes for wall bolts occur in masonry or tile joints. Secure panels to pilasters with brackets matching the wall brackets. Provide for adjustment due to minor floor variations. Locate head rail joints at pilaster center lines. Install adjacent components for consistency of line and plane. Equip each door with hinges, one door latch, and one coat hook and bumper. Align hardware to uniform clearance at vertical edges of doors.

- a. Secure panels to ceramic tile on hollow plastered walls or hollow concrete-masonry walls with toggle bolts using not less than 1/4-20 screws of the length required for the wall thickness. Provide toggle bolts with a load-carrying strength of not less than 600 pounds per anchor.
- b. Submit Installation Drawings for toilet partitions, room entrance screens, and urinal screens showing plans, elevations, details of construction, hardware, reinforcing and blocking, fittings, mountings and escutcheons. Indicate on drawings the type of partition, location, mounting height, cutouts, and reinforcement required for toilet-room accessories.

3.3 OVERHEAD-BRACED PARTITIONS

Secure pilasters to the floor with the anchorage device specified. Make all leveling devices readily accessible for leveling, plumbing, and tightening the installation. Secure overhead brace to the pilaster face with not less than two fasteners per face. Expansion shields have a minimum 2 inch penetration into the concrete slab. Make tops of doors parallel with the overhead brace when doors are in a closed position.

3.4 FINAL ADJUSTMENT

After completion of the installation, make final adjustments to the pilaster-leveling devices, door hardware, and other working parts of the partition assembly. Doors have a uniform vertical edge clearance of approximately 3/16 inch and rest open at approximately 30 degrees when unlatched.

3.5 CLEANING

Clean all surfaces and adjacent surfaces soiled as a result of the work, in an approved manner compliant with the manufacturer's recommended cleaning and protection from damage procedures until accepted. Remove all equipment, tools, surplus materials, and work debris from the site.

-- End of Section --

SECTION 10 28 13

TOILET ACCESSORIES
08/20

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-STD-1691

(1994; Rev F) Construction and Material
Schedule for Military Medical and Dental
Facilities

1.2 SUBMITTALS

Government approval is required for submittals . Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Product Schedule

Submit product Schedule indicating types, quantities, sizes, and installation locations by room for each toilet accessory item required. Identify locations using room designations indicated on the drawings.

SD-03 Product Data

Recycled content for stainless steel toilet accessories

Item A5080 Dispenser, Paper Towel, SS, Surface Mounted

Item A5090 Disposal, Sanitary Napkin, SS, Surface Mounted

Item A5109 Grab Bar, 1-1/2 inch Dia., SS, 2 Wall, W/C Accessible

Item A5195 Dispenser, Toilet Tissue, SS, 1-Roll, Surface Mntd

Submit catalog numbers, literature, data sheets, construction details, profiles, anchoring and mounting requirements ,including cutouts in other work and substrate preparation, and other pertinent data for each toilet accessory item to evaluate function, materials, dimensions and appearance.

SD-10 Operation and Maintenance Data

Item A5080 Dispenser, Paper Towel, SS, Surface Mounted

Item A5090 Disposal, Sanitary Napkin, SS, Surface Mounted

Item A5109 Grab Bar, 1-1/4 inch Dia., SS, 2 Wall, W/C Accessible

Item A5195 Dispenser, Toilet Tissue, SS, 1-Roll, Surface Mntd

Submit Data Package 1 for each toilet accessory item in accordance with Section **01 78 23** OPERATIONS AND MAINTENANCE DATA.

1.3 DELIVERY, STORAGE, AND HANDLING

Wrap toilet accessories for shipment and storage, then deliver to the jobsite in manufacturer's original packaging, and store in a clean, dry area protected from construction damage and vandalism.

1.4 WARRANTY

Provide manufacturer's warranty to repair or replace defective materials and workmanship for a period of one year from date of final acceptance of the work..

PART 2 PRODUCTS

2.1 ACCESSORY ITEMS

Provide toilet accessories where indicated in accordance with Contractor-provided [product schedule](#). Conform to the requirements for accessory items specified herein which are based on [MIL-STD-1691](#) Joint Schedule Numbers (JSN). Provide each accessory item complete with the necessary mounting plates of sturdy construction with corrosion resistant surface.

Provide stainless steel products listed herein manufactured from materials containing a minimum of 50 percent recycled content. Provide data identifying percentage of [recycled content for stainless steel toilet accessories](#).

2.1.1 Anchors and Fasteners

Provide corrosion-resistant anchors and fasteners capable of developing a restraining force commensurate with the strength of the accessory to be mounted and suited for use with the supporting construction. Provide oval heads exposed fasteners with finish to match the accessory. Provide fasteners proposed for use for each type of wall construction and mounting.

2.1.2 Finishes

Except where noted otherwise, provide the following finishes on metal:

Metal	Finish
Stainless steel	No. 4 satin finish
Carbon steel, copper alloy, and brass	Chromium plated, bright

2.1.3 Item A5080 Dispenser, Paper Towel, SS, Surface Mounted

Surface mounted unit constructed of stainless steel with satin finish, welded construction, and have full length piano hinge, tumbler lock, refill indicator. Unit has smooth corners, free of burrs and sharp edges. Unit has a capacity of 400 single fold paper towels.

Approximate size: 11 inches wide by 8 inches high by 6 inches deep.

2.1.4 Item A5090 Disposal, Sanitary Napkin, SS, Surface Mounted

Surface mounted sanitary napkin receptacle. Unit made of stainless steel with satin finish and all welded construction. Unit has piano hinge attached at the top and an integral finger depression for opening. For use with disposable paper liners, available separately. Unit may be attached to wall or toilet partition.

Approximate size: 7 inches wide by 4 inches deep by 10 inches high.

2.1.5 Item A5109 Grab Bar, 1-1/2 Inch Diameter, SS, 2 Wall, W/C Accessible

Grab bar of 1-1/2 inch diameter satin finish stainless steel with peened gripping surface for use in toilet stall/room. Snap-on flange covers for concealed mounting are stainless steel and equipped with two screw holes for attachment to wall. Grab bars designed to meet and exceed ADA requirements for structural strength. Grab bars designed to withstand loads of 900 pounds when properly installed. Clearance from wall to grab bar is 1-1/2 inches to meet ADA and ANSI codes.

2.1.6 Item A5195 Dispenser, Toilet Tissue, SS, 1-Roll, Surface Mounted

Concealed surface mounted single roll toilet tissue dispenser of satin finish stainless steel. Spindle to be free-spinning for non-controlled delivery, chrome-plated high impact resistant plastic and equipped with heavy-duty internal spring. Unit accommodates standard core toilet paper roll up to 5-1/2 inches diameter. Mounting hardware included.

Approximate size: 7-3/4 inches wide by 2 inches high by 4 inches deep.

PART 3 EXECUTION

3.1 INSTALLATION

Do not install items that show visual evidence of biological growth. Provide the same finish for the surfaces of fastening devices exposed after installation as the attached accessory. Provide oval exposed screw heads. Install accessories at the location and height indicated. Protect exposed surfaces of accessories with strippable plastic or by other means until the installation is accepted. After acceptance of accessories, remove and dispose of strippable plastic protection. Coordinate accessory manufacturer's mounting details with other trades as their work progresses.

3.1.1 Mounting (generally)

At studs employ screws sized for 1 inch penetration into wood back blocking; blocking shall be treated pine not smaller than 2 x 6 and secured to studs before rocking or plastering. Cover face of blocking with felt to avoid swelling of lumber by moisture absorption. Holes drilled through ceramic tile for screws shall be filled with grout just before inserting screws. Align items mounted in battery.

At exposed masonry surfaces and at hard tile on masonry install surface mounted units with expansion bolts. Recessed units shall be equipped with masonry lugs and be solidly grouted into masonry. All exposed bolts and

screws shall be chrome or cadmium plated (stainless steel at stainless accessories) phillips oval-head type.

Where a device when mounted will straddle a projecting wainscot cap, provide a plywood filler of proper thickness, with edges machine sanded and painted black. Size filler to reflect a 3/16 inch recess along edge of the device.

3.1.2 Surface Mounted Accessories

Mount on concealed backplates, unless specified otherwise. Conceal fasteners on accessories without backplates. Install accessories with corrosion-resistant fasteners as required by the construction. Install backplates in the same manner, or provide with lugs or anchors set in mortar, as required by the construction. Fasten accessories mounted on gypsum board and plaster walls without solid backing into the metal or wood studs, or to backplates secured to metal studs.

3.2 CLEANING

After installation, thoroughly clean exposed surfaces and restore damaged work to its original condition or replace with new work. Clean material in accordance with manufacturer's recommendations. Do not use alkaline or abrasive agents. Take precautions to avoid scratching or marring exposed surfaces.

-- End of Section --

SECTION 10 44 16

FIRE EXTINGUISHERS
11/19

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM E814 (2013a; R 2017) Standard Test Method for
Fire Tests of Penetration Firestop Systems

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 1 (2021) Fire Code

NFPA 10 (2022; ERTA 1 2021) Standard for Portable
Fire Extinguishers

NFPA 101 (2021; TIA 21-1) Life Safety Code

NFPA 241 (2022) Standard for Safeguarding
Construction, Alteration, and Demolition
Operations

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.157 (2003) Portable Fire Extinguishers

UNDERWRITERS LABORATORIES (UL)

UL 299 (2012; May 2021) Dry Chemical Fire
Extinguishers

1.2 SUBMITTALS

Government approval is required for submittals. Submit the following in accordance with Section **01 33 00** SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Fire Extinguishers

Cabinets

Schedule

SD-03 Product Data

Fire Extinguishers

Cabinets

Replacement Parts List

SD-04 Samples

Equipment Samples

SD-07 Certificates

Fire Extinguishers Certifications

Manufacturer's Warranty with Inspection Tag

1.3 DELIVERY, STORAGE, AND HANDLING

Protect materials from weather, soil, and damage during delivery, storage, and construction.

Deliver materials in their original packages, containers, or bundles bearing the brand name and the name and type of the material.

1.3.1 Samples

Provide the following [equipment samples](#): one full-sized sample of each type of cabinet being installed; [Submit sample for approval together with a color card and a shop drawing showing typical letter style, size and composition.](#)

Use approved samples for installation, with proper identification and storage.

1.4 WARRANTY

Guarantee that Fire Extinguishers are free of defects in materials, fabrication, finish, and installation and that they will remain so for a period of not less than [5](#) years after completion.

Submit the [manufacturer's warranty with inspection tag](#).

1.5 PROJECT SCHEDULE

For fire extinguishers. Coordinate final fire extinguisher schedule with fire protection cabinet schedule to ensure proper fit and function. Use same designations indicated on Drawings.

PART 2 PRODUCTS

Submit fabrication drawings consisting of fabrication and assembly details performed in the factory and product data for the following items: Fire Extinguishers; [cabinets](#).

2.1 SYSTEM DESCRIPTION

2.1.1 Types

Submit [fire extinguishers certifications](#) showing compliance with local codes and regulations.

Provide [fire extinguishers](#) conforming to [NFPA 10](#). Provide quantity and

placement in compliance with the applicable sections of NFPA 1, NFPA 101, NFPA 241, and 29 CFR 1910.157.

Provide multi-purpose dry chemical type fire extinguishers compliant with UL 299.

2.1.2 Material

Provide enameled steel extinguisher shell.

2.1.3 Size

5 pounds extinguishers.

2.2 EQUIPMENT

2.2.1 Cabinets

2.2.1.1 Material

Provide 18 gauge enameled steel case cabinets with anodized bronze fully glazed aluminum door and frame. .

2.2.1.2 Type

Provide semi-recessed and surface type cabinets as indicated.

Provide semi-recessed cabinet for a 4 inch wall.

Provide a fire rated cabinet, listed and labeled to comply with ASTM E814 for fire resistance wall rating as indicated

Door shall have matching brass pull, piano hinge, tension latch, and shall be fully glazed with 1/8 inch Plexiglas. Install handle of cabinet 3'-4" above finish floor.

2.2.1.3 Size

Dimension cabinets to accommodate the specified fire extinguishers.

2.2.2 Identification

Provide vertical lettering on the glazing complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as indicated by the drawings.

PART 3 EXECUTION

3.1 INSTALLATION

Install Fire Extinguishers where indicated on the drawings. Verify exact locations prior to installation.

Provide extinguishers which are fully charged and ready for operation upon installation. Provide extinguishers complete with Manufacturer's Warranty with Inspection Tag attached.

Install fire extinguishers in locations indicated and in compliance with requirements of authorities having jurisdiction.

Comply with the manufacturer's recommendations for all installations.

3.2 PROTECTION

3.2.1 Repairing

Remove and replace damaged and unacceptable portions of completed work with new work at no additional cost to the Government.

Submit [replacement parts list](#) indicating specified items replacement part, replacement cost, and name, address and contact for replacement parts distributor.

3.2.2 Cleaning

Clean all surfaces of the work, and adjacent surfaces which are soiled as a result of the work. Remove from the site all construction equipment, tools, surplus materials and rubbish resulting from the work.

-- End of Section --

SECTION 10 51 10

SOLID PLASTIC LOCKERS
05/11

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM B456 (2017; R 2022) Standard Specification for Electrodeposited Coatings of Copper Plus Nickel Plus Chromium and Nickel Plus Chromium

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FS AA-L-00486 (Rev J) Lockers, Clothing, Steel

1.2 SUBMITTALS

Government approval is required for submittals . Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Types

Location

Installation

Numbering system

SD-03 Product Data

Material

Locking Devices

Handles

Locker components

Assembly instructions

SD-04 Samples

Color chips

1.3 DELIVERY, HANDLING, AND STORAGE

Deliver lockers and associated materials in their original packages,

containers, or bundles bearing the manufacturer's name and the name of the material. Protect from weather, soil, and damage during delivery, storage, and construction.

1.4 FIELD MEASUREMENTS

To ensure proper fits, make field measurements prior to the preparation of drawings and fabrication. Verify correct [location](#)

1.5 QUALITY ASSURANCE

1.5.1 [Color Chips](#)

Provide a minimum of three color chip [sets of manufacturer's standard colors](#), not less than [3 inches](#) square, [for selection by the Architect](#).

Government may request performance-characteristic tests on assembled lockers. Tests and results must conform to [FS AA-L-00486](#). Lockers not conforming will be rejected.

PART 2 PRODUCTS

2.1 [TYPES](#)

Locker must have the following type and size in the location and quantities indicated. Locker finish colors will be as scheduled.

2.1.1 Single-tier Lockers

Single-tier lockers must be as follows:

Type STL-3: Single-tier locker [18 inches](#) wide, [18 inches](#) deep, and [72 inches](#) high, attached to [6-inch](#) high legs

2.2 [MATERIAL](#)

2.2.1 [High Density Polyethylene \(HDPE\)](#)

[polyethylene thermoplastic formed into solid plastic components with homogeneous color throughout, with smooth orange peel finish. Color to be selected from manufacturer's color range.](#)

2.2.2 [Heavy Duty Extruded Aluminum](#)

[ASTM B221, 6063-T6 alloy](#)

2.2.3 [Chromium Plated Steel](#)

[ASTM A167](#)

2.2.4 [Chromium Coating](#)

Nickel and chromium electrodeposited on the specified base metal. Conform to [ASTM B456](#), SC-3, as applicable to the base metal.

2.3 COMPONENTS

2.3.1 Built-In Locks

Provide **locking devices** as a padlock eye in the door latching mechanism.

2.3.2 Coat Hooks

Two-prong, high impact plastic, black finish, mounted to bottom of shelf or divider, one per door opening.

2.3.3 Door Handles

ADA compliant ergonomic handle, injection molded plastic

2.3.4 Doors

1/2 inch thick HDPE plastic, with venting top and bottom.

2.3.4.1 Hinges

Heavy duty extruded aluminum with corrosion free stainless-steel pin with black finish. A full height piano hinge may be provided if standard with the manufacturer. Bolt hinges to the door frame. Bolt, or rivet hinges to the door.

2.3.4.2 Latching Mechanisms

3/8-inch-thick HDPE plastic with multiple latch points, fastened with stainless steel tamper-resistant screws.

2.3.5 Latch Strikes

Fabricate from not less than 3/4 inch thick HDPE sheet, except latch strike may be continuous from top to bottom and fabricated as part of the door framing.

2.3.6 Back and Side Panels, Tops, and Bottoms

5/8 inch thick HDPE plastic sheet.

2.3.7 Sloping Locker Tops

Provide sloping locker tops in addition to the locker-section flat tops. Sloping tops must be continuous in length. Provide fillers or closures at the exposed end of sloping tops. Fabricate sloping tops from not less than 1/2 inch HDPE sheet..

2.3.8 Shelves

5/8 inch HDPE sheet.

2.3.9 Base Panels

5/8 inch HDPE sheet

2.3.10 Legs

Provide lockers without legs, as indicated.

2.3.11 Number Plates

3134 aluminum, Series 1100, H18, satin matte finish, fastened to locker with corrosion resistant stainless-steel rivets.

2.3.12 Fastening Devices

Provide bolts, nuts, and rivets as standard with the locker manufacturer..

2.4 FABRICATION

Fabricate locker components square and rigid; finish free from scratches and chips. Fabricate locker components for snap-together assembly or slide-together dovetail connections providing solid and secure, anti-racking construction. Fabricate adjacent lockers with common side panel.

PART 3 EXECUTION

3.1 ASSEMBLY AND INSTALLATION

Assemble lockers according to the locker manufacturer's instructions. Align lockers horizontally and vertically. Secure lockers to wall with screws as indicated. Bolt adjacent lockers together. Adjust doors to operate freely without sticking or binding and to ensure they close tightly.

3.2 NUMBERING SYSTEM

Install number plates on lockers consecutively as indicated.

3.3 FIELD QUALITY CONTROL

3.3.1 Repairing

Remove and replace damaged and unacceptable portions of completed work with new.

3.3.2 Cleaning

Clean surfaces of the work, and adjacent surfaces soiled as a result of the work, in an approved manner. Remove equipment, surplus materials, and rubbish from the site.

3.3.3 ADJUSTING

Adjust doors and latches to operate correctly.

-- End of Section --

SECTION 11 05 40

COMMON WORK RESULTS FOR FOODSERVICE EQUIPMENT
08/17, CHG 1: 02/18

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ANSI/ASHRAE 15 & 34 (2013) ANSI/ASHRAE Standard 15-Safety Standard for Refrigeration Systems and ANSI/ASHRAE Standard 34-Designation and Safety Classification of Refrigerants

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME A112.19.3/CSA B45.4 (2022) Stainless Steel Plumbing Fixtures

ASME B16.15 (2018) Cast Copper Alloy Threaded Fittings Classes 125 and 250

ASME B16.18 (2021) Cast Copper Alloy Solder Joint Pressure Fittings

ASME B16.22 (2021) Wrought Copper and Copper Alloy Solder Joint Pressure Fittings

ASME B16.26 (2018) Standard for Cast Copper Alloy Fittings for Flared Copper Tubes

AMERICAN WELDING SOCIETY (AWS)

AWS A5.8/A5.8M (2019) Specification for Filler Metals for Brazing and Braze Welding

AWS D1.1/D1.1M (2020; Errata 1 2021) Structural Welding Code - Steel

AWS D9.1/D9.1M (2018) Sheet Metal Welding Code

AWS D10.4 (1986; R 2000) Recommended Practices for Welding Austenitic Chromium-Nickel Stainless Steel Piping and Tubing

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M (2019) Standard Specification for Carbon Structural Steel

ASTM A123/A123M (2017) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and

Steel Products

ASTM A240/A240M	(2022b) Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM A269/A269M	(2015; R 2019) Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service
ASTM A270/A270M	(2015; R 2019) Standard Specification for Seamless and Welded Austenitic and Ferritic/Austenitic Stainless Steel Sanitary Tubing
ASTM A276/A276M	(2017) Standard Specification for Stainless Steel Bars and Shapes
ASTM A480/A480M	(2022a) Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip
ASTM A653/A653M	(2022) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A666	(2015) Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate and Flat Bar
ASTM B32	(2020) Standard Specification for Solder Metal
ASTM B43	(2020) Standard Specification for Seamless Red Brass Pipe, Standard Sizes
ASTM B88	(2022) Standard Specification for Seamless Copper Water Tube
ASTM C920	(2018) Standard Specification for Elastomeric Joint Sealants
ASTM C1330	(2002; R 2013) Standard Specification for Cylindrical Sealant Backing for Use with Cold Liquid-Applied Sealants
ASTM D520	(2000; R 2011) Zinc Dust Pigment
CSA GROUP (CSA)	
CSA Directory	(updated continuously online) Product Index
NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)	
ANSI/NEMA LD 3	(2005) Standard for High-Pressure Decorative Laminates

NEMA 250 (2020) Enclosures for Electrical Equipment
(1000 Volts Maximum)

NEMA ICS 2 (2000; R 2020) Industrial Control and
Systems Controllers, Contactors, and
Overload Relays Rated 600 V

NEMA ICS 6 (1993; R 2016) Industrial Control and
Systems: Enclosures

NEMA MG 1 (2021) Motors and Generators

NEMA MG 2 (2014) Safety Standard for Construction
and Guide for Selection, Installation and
Use of Electric Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 54 (2021) National Fuel Gas Code

NFPA 70 (2023) National Electrical Code

NSF INTERNATIONAL (NSF)

NSF Food Equipment (2005) NSF Product Listings of Food
Equipment and Related Products, Components
and Materials

NSF/ANSI 2 (2021) Food Equipment

NSF/ANSI 6 (2021) Dispensing Freezers

NSF/ANSI 7 (2021) Commercial Refrigerators and
Freezers

NSF/ANSI 8 (2021) Commercial Powered Food Preparation
Equipment

NSF/ANSI 14 (2021) Plastics Piping System Components
and Related Materials

NSF/ANSI 35 (2020) High Pressure Decorative Laminates
for Surfacing Food Service Equipment

NSF/ANSI 37 (2021) Air Curtains for Entrancesways in
Food and Food Service Establishments

NSF/ANSI 51 (2021) Food Equipment Materials

NSF/ANSI 59 (2020) Mobile Food Carts

NSF/ANSI 169 (2019) Special Purpose Food Equipment and
Devices

U.S. DEPARTMENT OF DEFENSE (DOD)

DOD 4000.25-1-M (2006) MILSTRIP - Military Standard
Requisitioning and Issue Procedures

U.S. DEPARTMENT OF ENERGY (DOE)

Energy Star (1992; R 2006) Energy Star Energy
Efficiency Labeling System (FEMP)

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910-SUBPART D Walking - Working Surfaces

29 CFR 1910.144 Safety Color Code for Marking Physical
Hazards

29 CFR 1910.145 Specifications for Accident Prevention
Signs and Tags

29 CFR 1910.212 Safety Standard for Machinery and Machine
Guarding

29 CFR 1910.306 Specific Purpose Equipment and
Installations

PL 109-58 Energy Policy Act of 2005 (EPAct05)

UNDERWRITERS LABORATORIES (UL)

UL 197 (2010; Reprint Jul 2020) UL Standard for
Safety Commercial Electric Cooking
Appliances

UL 207 (2022) UL Standard for Safety
Refrigerant-Containing Components and
Accessories, Nonelectrical

UL 471 (2010; Reprint Sep 2019) UL Standard for
Safety Commercial Refrigerators and
Freezers

UL 489 (2016; Rev 2019) UL Standard for Safety
Molded-Case Circuit Breakers, Molded-Case
Switches and Circuit-Breaker Enclosures

UL 763 (2018; Reprint Nov 2022) UL Standard for
Safety Motor-Operated Commercial Food
Preparing Machines

UL 1598 (2021; Reprint Jun 2021) Luminaires

UL Elec Equip Dir (2011) Electrical Appliance and
Utilization Equipment Directory

1.2 GENERAL REQUIREMENTS

Provide detailed Food Service Equipment Schedule conforming to
DOD 4000.25-1-M.

Provide Major electrically or gas powered equipment specified within this
section, and in Section 11 06 40.13 - Food Service Equipment Schedule,
conforming to EPA Energy Star requirements and labeling. Special purpose

equipment must conform to NSF/ANSI 169, NSF/ANSI 59, and NSF/ANSI 8.

1.2.1 Mechanical General Requirements

Section 23 03 00.00 20 BASIC MECHANICAL MATERIALS AND METHODS, applies to this section. Stainless steel plumbing fixtures must conform to ASME A112.19.3/CSA B45.4

Section 22 00 00 PLUMBING, GENERAL PURPOSE applies to this section. Coordinate the location of drainage receptacles with food preparation equipment requiring plumbing connections. All plastics and piping system components must conform to NSF/ANSI 14. Materials must conform to NSF/ANSI 51. Refrigeration equipment must conform to ANSI/ASHRAE 15 & 34, NSF/ANSI 37, NSF/ANSI 6, NSF/ANSI 7, UL 207, and UL 471.

1.2.1.1 American Gas Association Laboratories Standards

Gas-burning equipment must be designed for operation with the type of gas specified and be approved by CSA. Acceptable evidence of meeting the requirements of the applicable CSA Directory standards must be either CSA mark on equipment, a photostatic copy of the CSA appliance certificate, a listing of the specific food service equipment or appliance in the CSA Directory, or a certified test report from a nationally recognized independent testing laboratory, indicating that the specified equipment has been tested and conforms to the requirements of the applicable CSA standards.

1.2.2 Electrical General Requirements

All electrical work must conform to NFPA 70, and NEMA 250. Motors and controllers must conform to the requirements of NEMA ICS 2, NEMA ICS 6, NEMA MG 1, NEMA MG 2 and UL 763.

Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM, applies to this system.

1.2.3 Fungus Treatment of Electrical Components

Provide fungus treatment of all electrical components.

1.3 DESCRIPTION OF WORK

The work includes furnishing and installing food service preparation equipment, casework and related work. Verify all existing dimensions, contract drawings, product data and all related conditions prior to commencing rough-in work. Advise the Contracting Officer of all discrepancies prior to ordering equipment. Submit Contractor's Field Verification Data prior to the preconstruction meeting addressing the following:

- a. Field verify all horizontal and vertical dimensions.
- b. Review contract drawings and submittal data for accuracy and completeness.
- c. Field check installed utility capacity and location.
- d. Review critical systems/components for application and capacities such as for exhaust hoods, refrigeration systems, fire suppression systems, gas, water, and steam/condensate line sizes and manifold

configurations.

- e. Coordinate and verify delivery for access through finished openings and vertical handling limitation within the building.

Provide rough-in and connect utilities to equipment in accord with requirements specified in other sections of this specification and in accord with the physical dimensions, capacities, manufacturer's instructions, and other requirements of the equipment furnished.

1.3.1 Design Requirements

Submit detail drawings for all food service and storage equipment. Drawings must be 1/4 inch scale minimum.

Submit a complete Food Service Equipment Schedule, material data, and drawings as specified. Provide detail drawings showing complete wiring, piping, and schematic diagrams, and any other details required to demonstrate that the system is coordinated and properly functions as a unit. Drawings must show proposed layout and anchorage of equipment and appurtenances, and equipment relationship to other parts of the work, including clearances for maintenance and operation.

- a. Detail drawings by Contractor must be separate drawings and be the Contractor's standard sheet size, but not smaller than the contract drawings, indicating food service equipment and cold storage assemblies with itemized schedule, special conditions drawings indicating size and location of slab depressions, cores, wall openings, blockouts, ceiling pockets, blocking grounds, ceiling and wall access panels, rough-in plumbing/mechanical systems and rough-in electrical systems.
- b. Prepare and submit detail drawings that show the size, type, and location of equipment drain lines, and floor drains. Indicate drain lines from equipment, distances of drain lines and floor drain receptacles from equipment and aisles, and elevation views of drain piping and floor drains.
- c. Detail drawings by manufacturer must be separate drawings; manufacturer's standard size and indicate item number, name, and quantity, construction details, sections, and elevations, adjacent walls, columns, and equipment, plumbing and electrical schematics, and fabricated fixtures with single electrical or plumbing connection, and service access panels required for maintenance or replacement of mechanical or electrical components.

1.4 SUBMITTALS

Government approval is required for submittals. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Contractor's Field Verification Data

Manufacturer's Qualifications

SD-02 Shop Drawings

Detail Drawings

Food Service Equipment Schedule

Food Service Equipment Utilities Coordination Plan

Custom Fabricated Equipment

Installation Instructions and Diagrams

SD-03 Product Data

Food Service Equipment

Food Preparation Equipment

SD-04 Samples

Exterior Panel Finish Material

Interior Panel Finish Material

Sample Warranty

SD-05 Design Data

Manufacturer's Descriptive And Technical Literature

SD-06 Test Reports

Manufacturer's Test Data

Field Test Reports

SD-07 Certificates

National Sanitation Foundation Standards

Underwriters Laboratories Standards

Energy Star Labeled

PL 109-58 Compliant

Fabricator/Manufacturer Qualifications

Walk-In Refrigeration

Preservative-Treated Wood

Fire-Retardant Treatment

SD-08 Manufacturer's Instructions

Manufacturer's Instructions for shipping, handling, storage,
installation, and start-up.

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals

List of Authorized Local Service and Repair Entities

SD-11 Closeout Submittals

Manufacturer's Warranty

Contractor's Warranty for Installation

1.5 Submittal Requirements

In addition to the requirements of Section 01 33 00 provide the following information on Submittals:

The equipment item numbers shown on the submittals required above shall be the same as shown on contract documents. All submittals are to be in electronic (PDF) format. Reproduction of original contract documents is not acceptable for this purpose.

1.5.1 Product Data:

1. Submit illustrated brochures for manufactured or "buy-out" equipment items, line drawings, rough-in requirements, and a list of accessories or other specified additional requirements. Include items listed as "Future, Existing to Remain, Existing to be Relocated, and/or By Government." The omission of data does not reduce the obligation to provide items as specified.
2. The equipment cut sheets shall use Auto Quotes or similar, including coversheets for each item. Where a piece of equipment is used and specified with multiple item numbers assigned, the first item is to be provided with a cover sheet and datasheet. For additional identical items, provide cover sheets only.
3. On the brochure cover sheet, provide the following information:
 - a. Project name.
 - b. FSEC name.
 - c. Foodservice Consultant name.
4. On equipment cover sheets, provide the following information:
 - a. Item Number.
 - b. Equipment description.
 - c. Quantity.
 - d. Written specification/description of equipment provided.
 - e. Accessories.
 - f. Utilities.

1.5.2 Utilities Rough-in Drawings:

1. Submit fully dimensioned rough-in plans at 1/4 inch scale, in electronic format, showing all required mechanical, electrical, ventilation, water, waste, and refrigeration services required for equipment and rough-in location for same. Rough-in locations shown shall make allowances for required traps, switches, etc., thereby not requiring interpretations or adjustments on the part of other contractors. Drawings shall indicate dimensions for floor depressions, raised bases, wall openings, wall backing, recessed or wall-mounted control panels, etc., for equipment.
2. Drawings shall be dimensioned to the stub up or stub out, not to the connection on the equipment. 90-degree plug heads are recommended where available. Verify all NEMA plug types and lengths of cords from the equipment. Length is to be of adequate distance for outlets available and to allow equipment to be placed as shown on contract documents. Show convenience receptacle locations.
3. In the event rough-in is existing or has been completed before a roughin survey, field verify the provided rough-in locations and provide equipment to suit building conditions.
4. Provide a refrigeration system schematic piping plan indicating line size, elevation, trap locations, and all specified components required for the refrigeration system installation. The plan is to include equipment and parts provided by the remote refrigeration manufacturer. Verify refrigeration sizing is proper for line lengths determined by actual field conditions.

1.5.3 Shop Drawings:

1. Submit fully dimensioned and detailed shop drawings, in electronic format, of custom-fabricated equipment, including, but not limited to, stainless steel fabrication, walk-in cooler/freezer, remote refrigeration, exhaust hoods, utility distribution systems, and scullery equipment shall be submitted, drawn at 3/4 inch scale for elevations and 1-1/2 inch scale for sections. Drawings to show item number and quantity required for each detail. Omissions shall not relieve the Contractor of providing items as specified and shown on contract drawings.
2. Show adjacent walls and columns and identify countertop equipment showing item numbers and descriptions. Drawings shall show details of construction, installation, and relation to adjoining and related work where cutting or close-fitting is required.
3. Drawings shall indicate species and grades of materials, gauges, finishes, and hardware selections. Provide color, pattern, and/or samples for laminate, fiberglass, paint, or stain for approval by the Architect or Contracting Officer.
4. Drawings shall show all reinforcements, anchorage, and other work required for the complete installation of all fixtures.
5. Where the fabricator is to pre-wire components to the junction box, pull box, breaker panel, load center, etc., all electrical wiring, labeling, and method of certification is to be indicated on the drawings. Provide an electrical diagram to the on-site Electrical

Contractor.

1.5.4 Certifications

Submit certification for special materials as applicable:

1. Walk-In refrigeration manufacturer will have received the UL Seal of Approval and Factory Mutual's test approval for low CFC foam construction. The Foodservice Equipment Contractor shall submit a sample of the approval certificates for verification.
2. Preservative-treated wood certification: submit for architect's information only. Submit certification by treating plant stating chemicals and process used, the net amount of salts retained, conformance with applicable standards, and moisture content after treatment.
3. Fire-retardant treatment certification: submit for architect's information only. Submit certification by treating plant that fire-retardant treatment materials comply with governing ordinances and that treatment will not bleed through finished surfaces.

1.5.5 General Review and Procurement

- A. Submit rough-in drawings, shop drawings, color, and material samples, and bound brochures covering manufactured or "buy-out" items covering all work and equipment covered in this Section to the Contracting Officer as soon as possible but not later than four (4) weeks after the award of contract. After approval, furnish to the Architect and Contracting Officer, sets (as required) of shop drawings and brochures, corrected as required by virtue of review comments, for distribution to various interested trades on the project. All costs of reproductions and submissions shall be part of the contract.
- B. After initial review of submittal data, revise and resubmit only the data sheet, coversheets, rough-in, and/or shop drawings that have been revised. The entire submittal is not required for resubmission. After two resubmissions, the Contractor may be charged a fee for the Architect's continuous re-evaluation. This will be billed as an additional service.
- C. Do not begin fabrication of custom equipment until approvals of shop drawings have been received and until field measurements have been taken and recorded, where such measurements are necessary to assure proper conformance with the intent of the contract drawings and specifications.
- D. Field verify measurements, giving due consideration to any architectural, mechanical, or structural discrepancies that may occur during the construction of the space. Do not rely on or measure drawings for actual on-site dimensions. No extra compensation will be allowed for any difference between the actual dimensions secured at the job site and the dimensions shown on the drawings. Field dimensions shall be taken at the earliest opportunity so as not to delay deliveries and shall be submitted to the Consultant for consideration before proceeding with the fabrication of equipment.
- E. Shop drawings, details, and equipment reviewed are for a design concept only and do not relieve the Contractor of responsibility for

compliance with design drawings, details, and specifications, verification of utilities with equipment requirements for conformity and location, and verification of all dimensions of equipment and building conditions or reasonable adjustments due to deviations. All verifications should occur prior to ordering equipment.

- F. Prepare and submit for review a complete and itemized listing of items and services ordered, procured, and otherwise arranged for to complete their work, including purchase order numbers, projected ship dates, and pertinent comments. This listing shall be updated and distributed on a bi-monthly basis and on a weekly basis during the four (4) week period preceding the commencement of installation.

1.6 QUALITY ASSURANCE

1.6.1 Fabricator/Manufacturer Qualifications

- A. All custom fabricated equipment, such as tables, sinks, countertops, etc., must be manufactured by a foodservice equipment fabricator who has the facility, personnel, and engineering capability to meet the design requirements. Such a manufacturer shall be subject to the approval of the consultant. All work in the above category shall be manufactured by one manufacturer and shall be of uniform design and finish.
- B. The provider of this equipment must be able to show that he is now and for the past 5 years been engaged in the manufacture or distribution of foodservice equipment, as required under this contract.
- C. Foodservice equipment is to be supplied by a single Foodservice Equipment Contractor. Contractors bidding on the equipment specified in this section represent and warrant that:
1. They are financially solvent.
 2. They are experienced in and competent to perform the types of work to furnish the plans, materials, supplies, and/or equipment to be so performed or furnished herein.
 3. They are familiar with all federal, state, municipal, and department laws, ordinances, orders, and regulations that may affect the work of those employed therein, including, but not limited to, any special acts relating to the work or to the project of which it is a part.
 4. Such temporary and permanent work required by the Foodservice Equipment Contractor can be satisfactorily constructed and used for the purpose for which it is intended, and such construction will not injure any person or damage any property.
 5. They have carefully examined the plans, specifications, addenda, if any, and the site of the work and that, from their own investigations, they have satisfied themselves as to the nature and location of the work; the character, quality, and quantity of materials likely to be encountered; the character of equipment and other facilities needed for the performance of the work; the general and local conditions; and all other materials which may, in any way, affect the work or its performance.

D. Pre-approved Foodservice Equipment Contractors to include, but are not limited to:

1. Birmingham Restaurant Supply, Inc. (Bresco) 205.252.0076 / 800.344.2455
2. Mobile Fixture 251.342.0455 / 800.345.6458
3. H & R Restaurant Supply 205.409.0097 / 888.364.4080

1.6.2 Energy Star Labeled Model List

Provide documentation certifying that products provided are PL 109-58 compliant by meeting or exceeding Energy Star or FEMP efficiency requirements as defined at "Energy-Efficient Products at <http://www1.eere.energy.gov/femp/procurement>. Indicate Energy Efficiency Rating. Custom fabricated items, which do not bear the Energy Star label must be accompanied by energy efficiency data and submitted to the Contracting Officer for review.

1.6.3 National Sanitation Foundation Standards

Provide acceptable evidence of meeting the requirements of the applicable National Sanitation Foundation (NSF) equipment standards as listed in NSF Food Equipment displaying the NSF seal for the year the equipment was manufactured, a certification issued for special or specific food service equipment by NSF under their special one time contract evaluation and certification, or a certified test report from an independent testing laboratory, approved by the Office of the Surgeon General, indicating that the specific food service equipment has been tested and conforms to the applicable NSF standards.

1.6.4 Standard Products

Materials and equipment must be the standard products of manufacturer regularly engaged in the manufacture of the products and be essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Applications must be for equipment and materials under similar circumstances and of similar size. When two or more of the same products are supplied they must be products of one manufacturer. Equipment must be supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site.

Install equipment in accordance with the manufacturer's instructions and the best practices of the foodservice industry, with careful attention to eliminating all cracks, crevices, and concealed spaces in wet areas that would be difficult to clean or keep free of vermin and soil.

Foodservice equipment provided under this contract shall be manufactured and installed in conformance with the Williams-Steiger Occupational Safety Health Act of 1970.

Follow requirements of applicable codes, ordinances, and regulations for work and materials, including, but not limited to, those of The National Fire Protection Association, State Fire Marshall, State Board of Health, Local Health Codes.

Walk-in refrigeration unit panels shall meet ASTM E84 (UL 723) and be listed by Underwriters laboratories and by Factory Mutual as a Class I

building material.

Applicable standards comply with the following, as referenced herein:

1. American Institute of Timber Construction (AITC).
2. American National Standards Institute (ANSI).
3. American Plywood Association (APA).
4. American Society for Testing and Materials (ASTM).
5. American Wood Preservers Association (AWPA).
6. American Woodwork Standards (AWS)
7. Architectural Woodwork Institute (AWI) "Architectural Woodwork Quality Standards, Guide Specifications, and Quality Certification Program," Sixth Edition, 1994, herein referred to as AWI standards. Work shall comply with applicable portions of AWI standards.
8. Hardwood Plywood Manufacturers Association (HPMA).
9. National Electric Manufacturers Association (NEMA).
10. National Fire Protection Association (NFPA).
11. Underwriters Laboratories, Inc. (UL).
12. U.S. Dept. of Commerce, National Bureau of Standards
 - a. Lumber: PS 20-70.
 - b. Construction and Industrial Plywood: PS 1-83.

Whenever the drawings and specifications require larger sizes or higher standards than are required by the regulations, the drawings and standards shall govern.

Whenever the drawings and specifications indicate requirements that will violate the regulations, the regulations shall govern.

No extra charge will be paid for furnishing safety devices or other items required by the regulations but not specified or shown on the drawings.

Rulings and interpretations of enforcing agencies shall be considered part of regulations.

1.6.5 Nameplates

Provide each item of equipment bearing a stainless steel, aluminum, or engraved polyester nameplate, as standard with the manufacturer, located in a conspicuous position and permanently fastened to the equipment. Make name or identification plates the size standard with the manufacturer for the particular piece of equipment provided. Name plates must indicate the name of the manufacturer/trade name, serial number, make, and model number, pertinent ratings, operating characteristics, and other information as standard with the manufacturer, date of manufacture, electrical characteristics, and other applicable data, such as flow rate, temperature, pressure, capacity, and material of construction. Securely

fasten separate equipment identification plates with the contract number marked thereon, to the surface of each piece of equipment.

1.6.6 Underwriters Laboratories Standards

Provide electrically operated equipment in accordance with applicable UL standards [UL 489](#) and [UL 763](#). Provide a UL label on the equipment as evidence of meeting the requirements, including a UL listing mark per [UL Elec Equip Dir](#) or a certified test report from a nationally recognized independent testing laboratory indicating that the specific food service equipment has been tested and conforms to the applicable UL standards or equivalent OSHA Nationally Recognized Testing Laboratory (NRTL) standard.

The electrical wiring of motors, motor starters, switches, and thermostats of the equipment shall be an integral part of the unit, which shall contain a junction box for the connection of electrical service. All motor-driven equipment shall have thermal overload and underload protection.

1.6.7 Pre-Installation Conference

Thirty days prior to the commencement of work, notify the Contracting Officer that the following items are prepared and ready for review:

a. Preconstruction Submittals:

(1) Contractor's Field Verification Data

(2) [Manufacturer's Qualifications](#)

b. Shop Drawings, product data and installation instructions

(1) [Detail Drawings](#)

(2) [Food Service Equipment Schedule](#)

Submit in the same format as the equipment schedule on the drawings. Include [Energy Star](#) labeled model list.

(3) Food service equipment [utilities](#)

(4) [Custom fabricated equipment](#)

(5) [Installation Instructions and Diagrams](#)

c. Product Data:

[food preparation equipment](#)

d. Samples

(1) [Exterior panel finish material](#)

(2) [Interior panel finish material](#)

(3) [Sample Warranty](#)

e. Design Data

(1) Manufacturer's descriptive and technical literature

(2) Manufacturer's Test Data

f. Manufacturer's Instructions

Manufacturer's Instructions for shipping, handling, storage, installation, and start-up.

1.7 DELIVERY, STORAGE, AND HANDLING

Confirm the earliest and latest job site delivery dates of the Foodservice Equipment Contractor-provided equipment.

Unless otherwise directed, the following procedures apply:

1.7.1 Delivery

- a. Deliver field assembled fixed equipment integrated into structure to jobsite when required.
- b. Deliver fixed equipment not integrated into structure to the jobsite after completion of finished ceilings, lighting, and acidizing of the finished floor and wall systems, including painting.
- c. Deliver major movable equipment to inventory in a secured area for interim jobsite storage, or if secured area is not available, when fixed equipment installation/clean-up has been completed.
- d. Deliver minor appliances and loose items to the jobsite when the Contracting Officer is prepared to receive and inventory such items.
- e. Provide a structure sufficient to sustain the weight of the Foodservice Equipment and depressed slabs for drains grates and walk-in cooler/freezer when noted. Confirm that openings and passageways of sufficient size to permit the delivery and erection of the equipment to their respective locations without dismantling are provided. Assume responsibility for any equipment that must be entered through openings before doors and walls are finished. Coordination of these conditions is critical to the equipment installation.

1.7.2 Storage of Equipment and Accessories

Store delivered items with protection from weather, humidity, and temperature variation, dirt and dust, or other contaminants. Clearly label and identify all components with respective number as enumerated in approved Food Service Equipment Schedule.

1.7.3 Protection of Fixed/Fabricated Manufactured Equipment

Follow equipment manufacturer's recommendations to protect materials and equipment and prevent damage. Tape fiberboard or plywood to surfaces as required by equipment shape and installation access requirements. Do not use tape which may possibly damage finished surface.

Protect metal and millwork product finishes from damage during shipping, storage, handling, installation, and construction of other work in the same spaces. Wrap with self-adhesive protective paper of a type recommended by the metal and millwork manufacturer and crate each item of

equipment as needed for protection from damage. Do not remove protective coverings until work is installed and ready for cleaning and start-up.

1.7.4 Prohibited Use of Equipment

Do not use food service equipment as tool or material storage, work bench, scaffold, or stacking area.

1.7.5 Damaged Equipment

Immediately submit documentation to the Contracting Officer with a recommendation of action for repair or replacement and the impact on project schedule.

1.8 WARRANTY

All new equipment specified in this section and in Section 11 06 40.13 shall be guaranteed in writing for a period of one (1) year from the date of final acceptance. Any defect in material or workmanship shall be promptly rectified by the Foodservice Equipment Contractor without cost to the Government during this period.

Walk-in refrigeration units specified in this section shall be guaranteed in writing for a period of ten (10) years from the date of final acceptance. Any defect in material or workmanship shall be promptly rectified by the Foodservice Equipment Contractor without cost to the Government during this period.

All new self-contained or remote refrigeration systems in this section shall include start-up and a one (1) year service contract providing free service 24 hours per day, seven days per week, including all parts and labor. Compressors shall be covered by the manufacturer's optional extended warranty, giving components a minimum of five (5) years of warranty protection.

Assign any warranties longer than one (1) year to the Government at the end of the first year.

PART 2 PRODUCTS

2.1 MATERIALS

Food equipment must conform to OSHA standards 29 CFR 1910.144, 29 CFR 1910.145, 29 CFR 1910.212, 29 CFR 1910.306, and related NSF and UL standards

Floor areas adjacent to food preparation equipment point of operation, and working surfaces must conform to 29 CFR 1910-SUBPART D

Comply with EPA sustainable acquisition (SA) requirements; regarding insulation materials for all equipment designated within this section. Verify utility and other special requirements of foodservice equipment with plumbing, mechanical, and electrical plans prior to ordering equipment. Other materials must conform to the following:

2.1.1 Stainless Steel, Sheets and Formed, Nonmagnetic

ASTM A480/A480M or ASTM A240/A240M: 18-8, 300 Series, austenitic, polished to No.4 finish on exposed surfaces.

2.1.2 Stainless Steel Pipe, Tubing and Bars

ASTM A269/A269M, ASTM A270/A270M, ASTM A666. Provide seamless or welded pipe and tubing, of the gauge specified, of true roundness, and of material as specified for stainless steel. Seamless tubing must be thoroughly annealed, pickled, and ground smooth. Welded tubing must be thoroughly heat-treated, quenched to eliminate carbide precipitation and then drawn true to size and roundness, and ground. Provide No. 3 or 4 finish tubing when exposed to view.

Provide bars conforming to ASTM A276/A276M, ASTM A666, Type 302 or Type 304 or Type 316.

2.1.3 Galvanizing Repair Compound

ASTM D520, Type I pigment.

2.1.4 Brazing and Braze Welding Material

AWS A5.8/A5.8M, class as applicable.

2.1.5 Steel Structural Shapes for Framing

ASTM A36/A36M. Provide uniform structural shapes, ductile in quality, and of hard spots, runs, checks, cracks and other surface defects. Galvanize sections by the hot-dip process, conforming to ASTM A123/A123M.

2.1.6 Coatings

Provide durable, nontoxic, nondusting, nonflaking, and mildew-resistant type coatings, suitable for use with food service equipment and in conformance with NSF/ANSI 2. Application must be in accordance with the recommendations of the manufacturer.

2.1.6.1 Exterior Parts

Exterior, galvanized parts, exposed members of framework, and wrought steel pipe, where specified to be painted, must be cleaned, and free of foreign matter before applying a rust inhibiting prime and two coats of epoxy-based paint in accordance with Section 09 90 00 PAINTS AND COATINGS, unless otherwise specified. Color will be selected by the Contracting Officer from manufacturer's standard colors.

2.1.6.2 Chromium Plating

Apply chromium plating over nickel plating.

2.1.7 Zinc-Coated Steel

2.1.7.1 Sheets and Shapes

Provide zinc coated sheets conforming to ASTM A653/A653M, coating Class G90. Provide zinc coated shapes conforming to ASTM A36/A36M, in accord with ASTM A123/A123M.

2.1.8 Brass Piping and Fittings

Pipe must conform to ASTM B43. Fittings must conform to ASME B16.15.

2.1.9 Copper Tubing and Fittings

Provide copper tubing conforming to [ASTM B88](#), Type K, annealed, for buried or embedded in concrete installation and Type L, hard drawn, for above grade installation. Fittings must conform to [ASME B16.18](#), above grade, [ASME B16.22](#) or [ASME B16.26](#), above or below grade.

2.1.10 Solder Material

[ASTM B32](#), Sn96.

2.1.10.1 Lead-Free Solder

[ASTM B32](#), 95.5 tin-antimony solder or other "lead-free" solder. Use for all potable water copper tubing and fitting connections, and for solder joints in contact with food.

2.1.10.2 Tin-Lead Solder

[ASTM B32](#), alloy grade 50B for temperatures up to 150 degrees F and alloy grade 95TA for temperatures over 150 degrees F.

2.1.10.3 Silver Solder

[AWS A5.8/A5.8M](#), 15 percent silver base brazing alloy, melting point not less than 1000 degrees F.

2.1.11 Laminated Plastics

[ANSI/NEMA LD 3](#) and [NSF/ANSI 35](#).

2.1.12 Sealants

Sealants must conform to the requirements of [ASTM C1330](#), [ASTM C920](#).

2.2 CONSTRUCTION OF FABRICATED EQUIPMENT

2.2.1 Grinding, Polishing, and Finishing

Grind smooth all exposed welded joints and finish to match the adjoining material. Wherever materials have been depressed or sunken by welding operation, hammer and peen such depressions flush with the adjoining surface, and again grind to eliminate high spots. Polish and buff ground surfaces to match adjoining surfaces. Exercise care in the grinding operations to avoid excessive heating of the metal and metal discoloration. Abrasives, wheels, and belts used in grinding must be free of iron and not previously used on carbon steel. In all cases, the grain of rough grinding must be removed by several successively finer polishing operations. Final polishing operation must be uniform, smooth, and consistent. Make the grain direction of horizontal stainless steel surface longitudinal, including the splash back. Provide a mitered appearance when polishing at right angle corners. Provide close fit butt and contact joints not requiring solder as a filler. Wherever brake bends occur, the bends must be free of open texture or orange peel appearance. Where brake work does mar the uniform appearance of the material, remove such marks by grinding, polishing, and finishing. Make sheared edges free of burrs, projections, and fins. Where miters or bullnosed corners occur, finish such miters and corners with the underage of the material and grind

to a uniform condition. Overlapping of material is not acceptable. Provide #4satin finish for all exposed stainless steel surfaces. Finishes of materials, other than stainless steel, must be comparable in appearance to commercial mill finish. Exposed surfaces include:

- a. Exterior surfaces exposed to view.
- b. Interior surfaces exposed to view in doorless cabinets.
- c. Undersides of shelves with a ground finish of No. 90 grit or finer.

2.2.2 Fastening Devices

Provide fastening devices of the same material as the metal being joined when joint pieces are of similar metal. Fastening devices must be stainless steel, ASTM A666 when stainless steel is joined to dissimilar metal. Provide minimum 1/4-20 stainless steel stud bolts with length necessary to accept washers, and required nuts, and weld 9 inches on center maximum. Exposed surfaces of equipment must be free of bolts, screws, and rivet heads. Use stainless steel stud bolts to fasten tops of counters or tables to angle framing and trim to other surfaces. Such bolts must be the concealed type. Cap threads of stud bolts which are on the inside of fixtures and are either visible or might come in contact with a wiping cloth, with chrome plated washers, lock washers, and chromium-plated brass cap nuts. Wherever bolts are welded to the underside of trim or tops, uniformly finish the reverse side of the welds with the adjoining surface of the trim or the top. Dimples at these points are not acceptable.

2.2.3 Welding

2.2.3.1 Welds

Use tungsten inert gas process. Use filler metal compatible with the material being welded. Do not use carbon arc welding on tops of counters, tables, drainboards, exposed shelving, or sinks. Make welds ductile and of same color as adjoining surfaces.

2.2.3.2 Welding Rods

Perform all welding with welding rods of the same composition as the sheets or parts welded. Factory weld long section components to the greatest lengths possible to minimize field welded joints.

2.2.3.3 Weld Quality

Weld quality must conform to the requirements of AWS A5.8/A5.8M, AWS D1.1/D1.1M, AWS D10.4 and AWS D9.1/D9.1M. Factory weld long section components to the greatest lengths possible to minimize field welded joint.

2.2.4 Built-in Equipment Lighting

Built-in lighting must conform to UL 1598.

2.2.5 Sound Deadening of Counters and Sinks

Provide sound deadening for counter tops and sinks with 1/2 inch wide rope sealant positioned continuously between all contact surfaces of the frame-members and the underside of counter top, overselves and

undershelves. Tighten stud bolts for maximum compression and trim any excess sealant.

2.2.6 Heat Lamp/Display Wiring

Conceal heat lamp/display wiring in corner post(s).

2.2.6.1 Heat Lamps

Provide heat lamp units with consolidated chassis of longest possible length for multiple sections. Include integral incandescent display light with warm white lamps and wire to a recess mounted infinitely adjustable heat control with pilot light for each separate section. Tightly secure heat lamps to the underside of the serving shelf and provide a "USDA" approved heat protector between the heat lamps and the shelf. Maximum allowable temperature at the top of a serving shelf must not exceed 120 degrees F.

2.2.6.2 Display Light Modules

Provide Energy Star Labeled under-cabinet, shelf-mounted fixtures (not included with heat lamps) in 18 inch and 36 inch increments. Wire fixtures to a single recess mounted master switch per serving shelf.

PART 3 EXECUTION

3.1 INSTALLATION

Do not install building construction materials that show visual evidence of biological growth.

Prior to commencement of installation, perform a complete walk down of the facility with the Contracting Officer to verify readiness for installation.

Consult the mechanical, plumbing, and electrical drawings and their accompanying specifications to determine additional requirements of the work. Coordinate with all rough-in trades to ensure a satisfactory installation.

Provide adequate protection of all finished surfaces, fixtures, furnishings and other equipment to prevent any damage during the installation work.

Conduct installation procedures conforming to applicable NSF, OSHA and UL standards specified, and the manufacturer's instructions.

Uncrate, assemble, and level equipment. Repair any damaged or abraded surfaces. Set equipment temporarily in its final locations, permitting the plumbing, mechanical, and electrical trades to take the necessary measurements for the connection of the service lines. Then, move the equipment sufficiently to permit the installation of such service lines. After service line installation, realign equipment level and plumb, making the final erection as shown on the contract drawings. Except for mobile and adjustable-leg equipment, securely anchor and attach items and accessories to walls, floors, or bases with stainless steel bolts.

Equipment shall be installed to eliminate objectionable vibration.

Be responsible for the cutting of holes in equipment for pipes, drains, electric outlets, etc., as required to allow for efficient utility

connections to equipment. Work shall conform to the highest standards of workmanship and shall include welded sleeves, collars, ferrules, or escutcheons.

Flash food service cabinets located in wall openings to the walls with 20 gage stainless steel. Provide wall sleeves, chrome-plated cover plates, vermin proofing, and sealing of wall sleeves. Provide vermin proofing for all floor sleeves used. Seal around equipment flashing and flanges, at walls, floor, and ceiling in accord with Section 07 92 00 JOINT SEALANTS. Fillers must be continuous, without opening.

No drilling, cutting, burning, or welding of structural parts of building is permitted. Provide access panels for concealed valves, vent controls, and control devices and items requiring periodic operation, inspection, or maintenance.

Repair damage to the equipment and premises resulting from food service equipment installation and remove, daily, any debris. Dispose of all packaging and debris per Section 01 74 19.

Be responsible for keeping the area orderly during the entire time of installation. Clean foodservice equipment and fixtures thoroughly and ready for operation at the time the building is turned over to the Command.

Become familiar with and comply with all applicable codes and regulations. If authorities having jurisdiction require any portion of the equipment to be inspected, tested, or approved, the Foodservice Equipment Contractor and/or their equipment supplier shall bear all costs of such inspections, tests, or approvals.

Procure and deliver certificates of acceptance or of completion as required and issued by the State, Municipal, or other authorities to the Contracting Officer. File the certificate with the Architect certifying that the equipment is operating based on the manufacturer's recommendations. Coordinate the performance of these services, and both the manufacturer's representative and the Foodservice Equipment Contractor shall sign the certificate. The Contracting Officer may withhold payments that are due or that may become due until the necessary certificates are procured and delivered.

Coordinate equipment noted as being provided by the Owner or other product supplier. Do not install unless specifically directed to do so in the written specifications. Show on roughing-in plans the sizes, utilities, and other requirements provided in the specifications as if the equipment were contractor furnished.

Verify size and weight information of all service ware (glasses, plates, trays, cups, etc.) with the Owner. Verify carts, racks, and dollies fit into fixed equipment such as roll-in refrigeration, combi ovens, walk-in refrigeration, counters, etc.

Take full responsibility for any costs resulting from changes or variances in contract drawings and written specifications without written authorization from Architect and/or Contracting Officer for said changes or

3.1.1.1 Equipment Connections

Complete equipment connections for all utilities. Unless otherwise

specified, provide stainless steel exposed piping. Provide access panels of sufficient size and so located that concealed items may be serviced and maintained or removed and replaced.

3.1.2 Backflow Preventers

Furnish and install backflow preventers as specified. The Contractor is responsible to install backflow preventers as shown on the contract drawings and at all other locations necessary to preclude a cross-connect or interconnect between a potable water supply and any source of nonpotable water, or other contaminant. Install backflow preventers at all locations where the potable water outlet is below the flood level of the equipment, or will be located below the level of the contaminant. Provide backflow preventers of sufficient size to allow unrestricted flow of water to the equipment, and preclude the backflow of waste or other contamination into the potable water system.

3.1.3 Gas Equipment

Installation of gas operated equipment must conform to NFPA 54. Fasten a heavy duty steel cable, 3 to 6 inch shorter than the equipment connector, to the equipment and the walls.

3.1.4 Electrical Work

Electrical systems, components and accessories must be certified to be in accordance with NFPA 70 and the following:

3.1.4.1 Installed Equipment Load

If the electrical load of the approved equipment differs from that specified or shown on the drawings, provide and install electrical service compatible with the approved equipment.

Voltages shall be as indicated on contract drawings. Any differences in electrical characteristics at the job site from those shown on contract documents must be submitted to the Contracting Officer for consideration prior to ordering equipment.

3.1.4.2 Electrical Equipment and Components

Food service equipment furnished under this section must have loads, voltages, and phases compatible with building system, and conform to manufacturer standards.

3.1.4.3 Cords and Caps

Coordinate all food service equipment cord/caps with related receptacles. All 120/208/240 volt "plug-in" equipment must have Type S0 or SJ0 cord and a plug with ground, fastened to frame/body of item. Provide mobile equipment with a strain-relief assembly at the cord connection of the appliance. Mobile electrical support equipment and counter appliances mounted on mobile stands must have cord/cap assembly with cord-hanger as provided by the manufacturer.

3.1.4.4 Switches and Controls

Furnish on each motor-driven appliance or electrically heated unit a

suitably mounted control switch or starter of proper type in accordance with per UL 197 and UL 471. Switches, controls, control transformers, starters, equipment protection and enclosures must be Industry Standards for the related equipment environment.

All controls mounted on vertical surfaces of fixtures shall be set into recessed die-stamped stainless-steel cups or otherwise indented to prevent damage to the control switch.

3.1.4.5 Motors

Provide motors at 120, 240, 208/240 and 460/480 volts with starter, overload protection, and short circuit motor protection per manufacturer standards.

3.1.4.6 Heating Elements

Provide thermostatic controls for all electrically heated equipment. Equip water heating equipment with a positive low-water shut-off.

3.1.4.7 Receptacles and Switches

Install receptacles which are located in vertical panels of closed base bodies in 12 by 8-1/2 by 3 inch deep recessed mounting panel sloped on a 60-degree angle and turned up to the top of the opening. Prewire receptacles which are located in closed base fixtures to a junction box located within 6 inch from the bottom of the utility compartment. Horizontally mount receptacles which are installed in/on fabricated equipment in a metal box with a stainless steel cover plate.

3.1.4.8 Light Fixtures

Prewire light fixtures with lamps which are installed in/on fabricated or field-assembled equipment to a junction box for final connection (fixtures must be continuous run when indicated). Install fluorescent display light the full-length of the display stand and serving shelf with stud bolts or as indicated, and prewire through a support post to a recess-mounted switch. Install heat lamps to underside of serving shelf assemblies as specified. Heat lamp length for chassis must be sized per manufacturer or as indicated on the drawings. Electrically connect cold storage light fixtures through the hub fitting located on the top of the fixture. Horizontal conduit must be above the ceiling panels. Install plastic sleeves through ceiling panels for electrical conduit and seal all penetrations airtight at both sides of panel.

3.1.4.9 Final Electrical Connection Provisions

Tag final electrical connection points of equipment with item number, name (as indicated on FOOD SERVICE EQUIPMENT SCHEDULE) of devices on the circuit, total electrical load, voltage, and phase. Fabricated equipment containing electrically-operated components or fittings, indicated on utility connections drawings to be direct-connected, must have each component, fitting, or group thereof prewired to a junction box for final connection. Refer to the drawings for circuit loading.

Field-assembled equipment (example, prefabricated cold storage assemblies, conveyor systems, exhaust hoods) must have electrical components completely interconnected by this section for final connection as indicated on utility connection drawing. Prewire the following groups of

cold storage assembly electrical devices to a top-mounted junction box for final connection per compartment grouping, unless otherwise indicated.

- a. Light fixtures, switches, and heated pressure-relief vent.
- b. Door/jamb heater and temperature monitors/alarms.
- c. Evaporator fans, defrost elements, freezer fan door switch, and drain line heaters.

All electrical inter-wiring done in the fabricator's shop or in the field shall be fully tested and certified by a licensed independent agency. The testing agencies shall be approved by the local authorities.

- a. Provide a complete wiring diagram indicating connection points, types of conduit, junction boxes, terminal boxes, breaker panels, shunt-trip breakers for cooking equipment, and other miscellaneous devices in the fabricator's shop drawings.
- b. The testing agency's name and contact person, as well as verification that the agency is accepted by local inspectors, shall be submitted to the Contracting Officer prior to the fabrication of custom equipment.

3.1.4.10 Lamps

Provide food service equipment containing light fixtures with standard appliance type bulbs or energy efficient appliance type bulbs as indicated on the drawings. Exposed fluorescent lamps above or within a food zone must have plastic coated T-8 energy efficient lamps or standard lamps, sleeved in plastic tube with end caps.

3.1.5 Plumbing Work

Furnish equipment with faucets, mixing valves, back-flow preventers, and sink waste assemblies, as specified in this section. All backsplash-mounted faucets shall be provided with double male nipples having locknuts for rigidly securing the tap to the backsplash. Nipple-locknut assembly shall be provided under this section as part of the faucet.

Pre-pipe all waste and supply piping for built-in fixtures in fabricated counters to shut off or control valves, ready for final connection by the General Contractor. Final connections will be by the General Contractor unless otherwise specified.

Tag all plumbing final connection points of equipment, indicating item number, name of devices or components, and type of utility (water, gas, steam, drain). Provide extensions of indirect waste fitting to open-sight hub drain, floor sink or floor drains from food service equipment.

3.1.6 Walk-in refrigeration:

1. Erect walk-in refrigeration units with factory-trained and certified installers or technicians supervised by factory personnel. Furnish remote refrigeration systems by the walk-in refrigeration unit manufacturer and installed by factory- authorized personnel.
2. Provide junction boxes, one for each unit section, to connect service for lights and heater cables. Make connections from electric panels to

control panels on compressors and to respective junction boxes.

3. Provide control wiring between evaporator units, compressor units, and related control items. All wiring shall be copper run through a rigid PVC conduit. Wiring and conduit sizing shall conform to the requirements of The State of Alabama Electric Code.
4. All conduits inside of units shall be of "Seal-Tite" type.
5. Conceal conduits, wiring, and refrigerant lines within the walls, ceilings, and floors of the building.
6. Testing and initial operation of this equipment will be supervised by a qualified representative of the balanced refrigeration system manufacturer.

3.2 MANUFACTURER'S FIELD SERVICES

Furnish manufacturer's representatives who are directly employed by the equipment manufacturers and trained to perform the services specified. The manufacturers representatives must provide advice and services on the following matters:

Starting equipment and training Government personnel as to its proper care, operation, maintenance and safety procedures.

Provide on-site operational and functional testing of the installed equipment. Defects or deficiencies will be corrected at no additional expense to the satisfaction of the Contracting Officer.

3.3 LOCATIONS AND CLEARANCES

Locate equipment to provide working space for necessary servicing such as shaft removal, disassembling, replacing or adjusting drives, motors, or shaft seals, access to water heads and valves of shell and tube equipment, tube cleaning or replacement, access to automatic controls, lubrication, oil draining and working clearance.

3.4 IDENTIFICATION TAGS AND PLATES

Provide equipment with tags numbered and stamped for their use as indicated on the Food Service Equipment Schedule. Provide brass or non-ferrous plates and tags. Minimum letter and numeral sizes are 1/8 inch high.

3.5 OPERATION AND MAINTENANCE MANUALS

Submit six copies of operating instructions outlining the step-by-step procedures required for equipment start-up, operation and shutdown. Include the manufacturer's name, model number, service manual, parts list, and a brief description of equipment and basic operating features.

Submit 6 copies of maintenance manuals listing routine maintenance procedures, possible breakdowns and repairs, trouble shooting guides, and containing the following:

- a. Front and rear protective covers with labeled project name.
- b. Index indicating item number, quantity, description, manufacturer's

name, and model number.

- c. Maintenance instructions for stainless steel and plastic laminate.
- d. Manufacturer's catalog specification sheets and manufacturer's detail and control drawings.
- e. Manufacturer's operation manual outlining the step-by-step procedures for equipment installation, startup, basic operation features, and operation shutdown.
- f. Manufacturer's maintenance manual listing routine maintenance procedures, possible breakdowns, repairs, and troubleshooting guides. Include simplified diagrams for the equipment as installed.
- g. Manufacturer's list of parts and supplies with current unit price and address of manufacturer's parts supply warehouse.

Include simplified wiring diagrams in the instructions. Framed instructions under glass or in laminated plastic, including wiring and control diagrams showing the complete layout of the entire system, must be posted where directed. Prepare in typed form, condensed operating instructions explaining preventative maintenance procedures, methods of checking the system for normal safe operation, and procedures for safely starting and stopping the system, framed as specified above for the wiring and control diagrams, and posted beside the diagrams. Submit proposed diagrams, instructions, and other sheets, prior to posting. Post the framed instructions, including wiring and control diagrams, before acceptance testing of the systems.

3.6 INSTRUCTIONS TO GOVERNMENT PERSONNEL

Prepare and conduct a training course for the operating staff as designated by the Contracting Officer. The training must consist of a total 8 hours of normal working time and start after the system is functionally completed but prior to final acceptance tests. Cover in the field instructions the items contained in the operating and maintenance instructions, as well as demonstrations of routine maintenance operations. Notify the Contracting Officer at least 14 days prior to date of proposed conduction of the training course.

Submit a [list of authorized local service and repair entities](#) to the Contracting Officer 14 days prior to conducting the training course.

3.7 TESTS

Perform the tests including everything required. Notify the Contracting Officer, in writing, 10 days before performing tests. Perform tests in the presence of a manufacturer's representative and Contracting Officer.

3.7.1 Initial Start-Up and Operational Test

Provide all lubricants and accessories before initial start-up. Start and operate all equipment. Follow the manufacturer's procedures and place the systems under all modes of operation. Supplement initial charges of lubricating oil to assure maximum operating capacity. Adjust all safety and automatic control instruments. Record manufacturer's recommended readings hourly. Operational tests must cover a period of not less than 3 days.

3.7.2 Test Reports

Submit the final **field test reports** for each system tested, describing test apparatus, instrumentation calculations, and equipment data based on industry standard forms or reasonable facsimiles thereof. Data must include: compressor suction and discharge pressure; refrigerant charge pump, compressor and air moving device ampere readings; power supply characteristics, including phase imbalance, with 1/2 percent accuracy; thermostatic expansion valve superheat-value as determined by field test; subcooling; high and low refrigerant temperature switch set-points; low oil pressure switch set-point; defrost system timer and thermostat set-points; moisture content; ambient, condensing and coolant temperatures; capacity control set-points; field data and adjustments which affect unit performance and energy consumption. Where final adjustments and settings cannot be permanently marked or drilled and pinned as an integral part of device, include adjustment and setting data in test report.

3.7.3 Cleaning and Adjusting

Test and adjust equipment for proper operation. Test rotating components and motors for proper rotation. Lubricate moving parts if suggested by manufacturer's literature. Prior to acceptance of project, clean and sanitize equipment both inside and outside.

3.8 **MANUFACTURER'S WARRANTY**

Submit all manufacturers' signed warranties to Contracting Officer prior to final commissioning and acceptance.

3.9 **CONTRACTOR'S WARRANTY for INSTALLATION**

Submit contractor's warranty for installation to the Contracting Officer prior to final commissioning and acceptance.

-- End of Section --

SECTION 11 06 40.13

FOODSERVICE EQUIPMENT SCHEDULE
08/17

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN WELDING SOCIETY (AWS)

AWS A5.8/A5.8M (2019) Specification for Filler Metals for
Brazing and Braze Welding

NSF INTERNATIONAL (NSF)

NSF Food Equipment (2005) NSF Product Listings of Food
Equipment and Related Products, Components
and Materials

NSF/ANSI 2 (2021) Food Equipment

NSF/ANSI 169 (2019) Special Purpose Food Equipment and
Devices

U.S. DEPARTMENT OF DEFENSE (DOD)

DOD 4000.25-1-M (2006) MILSTRIP - Military Standard
Requisitioning and Issue Procedures

U.S. DEPARTMENT OF ENERGY (DOE)

Energy Star (1992; R 2006) Energy Star Energy
Efficiency Labeling System (FEMP)

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA WaterSense (2006) WaterSense Water Efficiency
Labeling System

1.2 DEFINITIONS

Terms used in paragraph FOOD SERVICE EQUIPMENT SCHEDULE are defined as follows:

- a. Sheet Pan: Standard 18 by 26 by 1 inch deep pan, unless otherwise noted.
- b. Pan: Standard 12 by 20 by 6 inch deep pan.
- c. Serving Tray: Cafeteria tray 14 by 18 inch, unless otherwise noted.
- d. 115-60-1: 115-volt, 60-hertz, 1-phase electric service and connection.

- e. 208-60-1: 208-volt, 60-hertz, 1-phase electric service and connection.
- f. 208-60-3: 208-volt, 60-hertz, 3-phase electric service and connection.

1.2.1 Abbreviations

Abbreviations used in paragraph FOOD SERVICE EQUIPMENT SCHEDULE are defined as follows:

AMPS:	Amperes
BTU:	British Thermal Units
CRS:	Corrosion Resistant Steel
CW:	Cold water
DIA:	Diameter
DR:	Drain
FED:	Federal Specification
G:	Gas
GAL:	Gallon
HP:	Horsepower
HW:	Hot Water
IN:	Inches
JSN:	Joint Schedule Numbers
KW:	Kilowatts
L:	Left
LB:	Pounds

LOG CLASS:	Logistical Classification
MIL:	Military Specification
MIN:	Minimum
NSF:	National Sanitation Foundation
R:	Right
SS:	Stainless Steel
STM:	Steam
x:	By, in usage describing dimensions of a rectangular solid

1.2.2 Dimensions

Dimensions used in paragraph FOOD SERVICE EQUIPMENT SCHEDULE are in inches, unless otherwise noted. Dimensions are listed in order of length, width, and height, unless otherwise noted. Terms are defined as follows:

- a. Length: Distance across front of equipment
- b. Width: Distance from front edge to back edge
- c. Height: Distance from bottom edge to top of equipment
- d. Depth: Distance from rim to bottom at drain, as in a sink.

1.2.3 Logistical Classification

Method of Procurement listed in paragraph FOOD SERVICE EQUIPMENT SCHEDULE is defined as follows:

- a. Class A: Contractor-furnished and Contractor-installed.
- b. Class B: Government-furnished and Contractor-installed.
- c. Class C: Government-furnished and Government-installed.
- d. Class D: Government-furnished as leased equipment and Government-installed.
- e. Class E1: Government-furnished and Government-installed.
- f. Class E2: Government-furnished and Contractor-installed.

Equipment designated Logistical Class "C" "D" "E1" will be Government-provided. Equipment which is Government-provided will be

furnished and installed by the Government in space made available by the Contractor and with rough-in made by the Contractor in accord with the information made available or referenced herein or indicated.

1.3 GENERAL REQUIREMENTS

Submit detailed Food Service Equipment Schedule conforming to DOD 4000.25-1-M. Electrically powered equipment specified within this section must conform to EPA Energy Star requirements and labeling. Food Service Equipment must conform to NSF/ANSI 2 and NSF Food Equipment standards. Special purpose equipment must conform to NSF/ANSI 169. Submit in the same format as the equipment schedule on the drawings. Include Energy Star Labeled models and EPA WaterSense Fixtures.

The Contract Drawings indicate the general arrangement of piping and the location of equipment. Slight changes due to the varying dimensions of equipment and wall construction shall be permitted with approval by the Architect/Contracting Officer. Should it be deemed necessary to deviate from the arrangement indicated to work with structural or other field conditions, provide revised drawings showing such deviations for approval. Changes will be provided without expense to the Government.

1.3.1 Manufacturer's Directions

Follow manufacturer's directions in all cases where manufacturers of articles used in this contract furnish directions or prints covering points not shown on drawings or specifications.

1.3.2 Industry Standards

- A. Equipment specified herein shall be fabricated to conform to the "Food Equipment Standards" of the National Sanitation Foundation (NSF). Equipment shall be installed in accordance with the standards of NSF and bear the NSF seal. This shall include any pending standards which shall become applicable at the time equipment is delivered. Any differences of opinion on sanitation shall be referred to the State Department of Health for a ruling.
- B. Equipment shall be installed in accordance with the manufacturer's instructions and the best practices of the foodservice industry, with careful attention to eliminating all cracks, crevices, and concealed spaces in wet areas that would be difficult to clean or keep free of vermin and soil.
- C. Foodservice equipment provided under this contract shall be manufactured and installed in conformance with the Williams-Steiger Occupational Safety Health Act of 1970.
- D. Work and materials shall follow requirements of applicable codes, ordinances, and regulations, including, but not limited to, those of The National Fire Protection Association, State Fire Marshall, State Board of Health, Local Health Codes, etc.
- E. Electrically operated and/or heated equipment, fabricated or otherwise, shall conform to the latest standards of the National Electric Manufacturers Association (NEMA). Equipment shall comply with the State of Alabama Electric Code and bear the label from an approved testing laboratory (UL or ETL).

- F. The electrical wiring of motors, motor starters, switches, and thermostats of the equipment shall be an integral part of the unit, which shall contain a junction box for the connection of electrical service. All motor-driven equipment shall have thermal overload and underload protection.
- G. Walk-in refrigeration unit panels shall meet ASTM E-84 (UL-723) and be listed by Underwriters laboratories and by Factory Mutual as a Class I building material.
- H. Applicable standards comply with the following, as referenced herein:
 - 1. American Institute of Timber Construction (AITC).
 - 2. American National Standards Institute (ANSI).
 - 3. American Plywood Association (APA).
 - 4. American Society for Testing and Materials (ASTM).
 - 5. American Wood Preservers Association (AWPA).
 - 6. American Wood Systems (AWS)
 - 7. Architectural Woodwork Institute (AWI) "Architectural Woodwork Quality Standards, Guide Specifications, and Quality Certification Program," Sixth Edition, 1994, herein referred to as AWI standards. Work shall comply with applicable portions of AWI standards.
 - 8. Hardwood Plywood Manufacturers Association (HPMA).
 - 9. National Electric Manufacturers Association (NEMA).
 - 10. National Fire Protection Association (NFPA)
 - 11. Underwriters Laboratories, Inc. (UL).
 - 12. U.S. Dept. of Commerce, National Bureau of Standards
 - a. Lumber: PS 20-70.
 - b. Construction and Industrial Plywood: PS 1-83.
- I. Whenever the drawings and specifications require larger sizes or higher standards than are required by the regulations, the drawings and standards shall govern.
- J. Whenever the drawings and specifications indicate requirements that will violate the regulations, the regulations shall govern.
- K. No extra charge will be paid for furnishing safety devices or other items required by the regulations but not specified or shown on the drawings.
- L. Rulings and interpretations of enforcing agencies shall be considered part of regulations.

1.3.3 Design Requirements

Submit detail drawings for all food service equipment and accessory items. Drawings must be 1/4 inch scale minimum.

Submit a complete list of equipment, material data, and drawings as specified.

1.4 SUBMITTALS

Government approval is required for submittals . Coordinate submittals with Section 11 05 40. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Food Service Equipment Schedule

PART 2 PRODUCTS

2.1 MATERIALS

- A. Stainless steel: Austenitic steel alloy ASTM A666 type 304 stainless steel. Type 430 stainless steel (straight chrome - no nickel) shall not be accepted for custom fabricated equipment.
- B. Stainless steel sheets shall be manufactured to the standards set forth by the U.S. Standard for Sheet Metal and have a genuine mill finish of not less than commercial No. 4 on the exposed side and No. 2 on the unexposed side. Unless specified, no material shall be finished lighter than 20 gauge for custom fabricated equipment. All stainless steel shall be stretcher leveled, with a thickness of:
 - 1. 14 Gauge - Not less than 0.075 Inch
 - 2. 16 Gauge - Not less than 0.063 Inch
 - 3. 18 Gauge - Not less than 0.050 Inch
 - 4. 20 Gauge - Not less than 0.038 Inch
- C. Welding: Electric arc or oxy-acetylene gas. Welding shall be done with a rod of the same material and full penetration in the entire length of the joint. Welds to be flat without buckles, voids, or imperfections. All welds shall be ground smooth to match the original grain, flush with adjacent surfaces, and conditioned to eliminate dangerous surfaces. Shear cuts or bends that tend to open the surface of the metal shall be rewelded, ground, and polished. Ends and edges which are rough or sharp shall be filed and ground to a safe, smooth finish before delivery to the job site.
- D. When stainless steel sheets have the grain running in different directions, the sheets shall be so jointed, and welds run and finish in such a manner as to make the sheets appear as one continuous product.
- E. Galvanizing shall be applied to rolled shapes in conformance with

ASTM A123, coating designation G-90, and to sheets in conformance with ASTM A526, coating designation G-90.

- F. Galvanized steel sheets shall be cold-rolled, stretcher leveled, bonded, and rerolled to ensure a smooth surface.
- G. Castings shall be corrosion-resisting metal containing not less than 30 percent nickel. All castings shall be rough ground, polished, buffed to a bright luster, and free from pit marks, runs, checks, burrs, and other imperfections. In lieu of corrosion-resisting metal castings, die-stamped or cast 18-8 stainless steel will be acceptable.

2.2 MANUFACTURED ITEMS

- A. Except when specified otherwise under the individual item specifications in the "Schedule of Equipment", all items of standard manufactured equipment furnished shall be complete in accord with the manufacturer's standard specifications for a specific unit of the model called for, including finishes, components, attachments, etc.
- B. The manufacturer and models indicated below and in the Food Service Equipment Schedule are provided for guidance regarding quality and function required for the project and are not intended to limit selection. Obtain equipment of like families through the same manufacturer.

2.2.1 Nameplates:

- A. Nameplates shall be provided on each "buy-out" product identifying the product manufacturer, model number, serial number, date of manufacture, electrical characteristics, and other identifying information for use in warranties and securing replacement parts.
- B. The nameplates may be on the back or bottom of small and portable equipment, but on heavy, permanently installed equipment, the nameplate shall be visible without searching. Electrical equipment shall have plates giving electrical characteristics.
- C. Nameplates shall fit snugly against the surface of the equipment, shall be no larger than necessary, shall be free of rough edges, and shall be attached in such a manner that it will not interfere with the sanitation of the equipment.
- D. Separate equipment identification plates with the contract number marked thereon shall be securely fastened to the surface of each piece of equipment. The identification plate and information imprinted thereon shall be as permanent as the life expectancy of the equipment to which it is affixed.

2.3 FABRICATED METAL EQUIPMENT

2.3.1 Metal Tops:

- 1. Metal tops shall be constructed of 14-gauge stainless steel with butt joints welded, ground, and polished smooth, resulting in a one-piece top without joints and crevices. Tops are to be reinforced with 14-gauge stainless steel channel irons, 1-inch by 5-inch by 1-inch. Channel irons shall be securely fastened to the underside, on 30-inch centers, by studs or welding, in a vermin-proof manner. Freestanding

ends are to be turned down 1-3/4-inch on the bull-nose edge or 2- inch on rolled down the edge, with exposed corners rounded on a 2-1/2-inch radius or bull-nose corner.

2. Where the table borders or is adjacent to the wall, provide an 8-inch-high backsplash with a 2-inch turn back on a 45-degree angle to the wall unless otherwise specified. Provide welded enclosed ends unless otherwise specified.
3. Where legs, standards, pipes, or pipe chases pass through a work area or tabletop, they shall pass through 3-inch-high stainless-steel sleeves, with the periphery fully welded and polished to match adjacent surfaces.
4. Sound deadening, minimum 1/8-inch thick, shall be applied to the undersides of dish tables and allowed to dry thoroughly before being finished with two (2) coats of epoxy paint.
5. See drawings for typical details.

2.3.2 Sinks

:

1. Sinks shall be constructed of 14-gauge stainless steel sheets with interior corners rounded on a minimum 1/2-inch radius. The bottom corners shall be fully coved.
2. Sinks to be welded into tabletops with joints ground, polished, and made to match adjacent surfaces.
3. Each pot sink compartment shall have a cut-out on the rear to accommodate the overflow assembly provided with the drain assembly. Overflow and drain assemblies shall be installed and made watertight.
4. Provide each sink with a 2-inch chromium-plated waste outlet with a stainless-steel strainer and chromium-plated tailpiece. Provide a rotary lever handle waste valve. Wastes are to be depressed in sink bottoms, with bottoms inclining down towards the wastes. Provide pot sinks with overflow assembly.
 - a. Wastes for pot sinks to be T&S Brass Model No. B-3940-01.
 - b. Wastes for prep sinks shall be T&S Brass Model No. B-3940.
 - c. Products manufactured by Component Hardware and Dormont, modified to comply with specifications, are also acceptable.
5. The rotary handle shall have a front stainless-steel bracket or support welded to the underside of the sink compartment.

2.3.3 Drain tables and drain boards

Construct of 14-gauge stainless steel, size and shape as specified, integral with sinks. Construct drain tables or boards to allow liquids to drain into sinks. The front and free ends are to be constructed with a minimum 3-inch-high by 1-1/2-inch rolled rim on a 180-degree turn unless otherwise specified.

2.3.4 Undershelves and intermediate shelves

Construct of 18-gauge stainless steel and notched to fit around legs. Provide a 2-inch turn-up at the rear. Shelves shall be fixed in place unless otherwise specified.

2.3.5 Over shelves:

1. Over shelves shall be constructed of 16-gauge stainless steel with edges rolled up or down as specified.
2. Table-mounted over shelves shall be supported by 16-gauge stainless steel tubular legs. Legs are to be securely fastened to the tabletop with 1-5/8-inch stainless steel supports with plated inside liner. Support to lock in place with a single set screw.
3. Cantilevered over shelves shall be supported on the table's extended rear legs and 14-gauge stainless steel flag brackets.
4. Wall-mounted over shelves shall be secured to the wall using stainless steel screws with expansion shields. Brackets shall be spaced at 4 feet on center maximum.

2.3.6 Doors:

1. Hinged doors shall be double pan construction with an 18-gauge stainless steel face and 20-gauge stainless steel rear unless otherwise specified. Doors shall be a maximum of 1-5/8 inches thick and filled with sound-deadening material. Corners shall be welded, ground, and filed smoothly.
2. Provide the full width of the door front with an integral horizontal pull.
3. Mount hinged doors on stainless steel lift-off hinges.

2.3.7 Drawers:

1. Lift-out type drawer body to be constructed from a single sheet of 20-gauge stainless steel. Drawer to be 20-inches by 20-inches by 5-inches-deep with coved inside corners unless otherwise specified.
2. Construct drawer front of double-wall stainless steel with 16-gauge exterior and 20-gauge interior. Provide with integral horizontal pull. Fill the void in the drawer front with sound-deadening material.
3. Mount the drawer pan in an 18-gauge stainless steel cradle with roller bearing slides with stops. Enclose the drawer in an 18-gauge stainless steel housing on the sides and rear. Design pan carrier to open fully without tilting. When fully extended, the drawer shall support a minimum of 200 pounds.
4. Provide manually operated release latches to allow drawer removal.
5. Drawer assemblies shall be positive self-closing types.

2.3.8 Legs, braces, gussets, and feet

1. The height of tables and other fabricated equipment shall be as

specified.

2. Legs shall be continuously welded, ground smooth, and polished to have a uniform finish. Legs are to be spaced at intervals of 72" maximum on center, braced by a 1-5/8-inch outside diameter 16-gauge stainless steel tube or undershelf welded to the legs 10 inches above the finished floor. Braces shall be constructed to form rectangular or "H" frames, and there shall be at least one (1) brace welded to each leg. Weld around the periphery at the joint to the legs and grind smoothly.
3. Gussets shall be a 3-1/2" inch-high cylindrical leg socket designed to accept the legs provided. The body shall be flared out to a 2-3/4-inch diameter at the top for easy welding. Provide a locking set screw to assure secure assembly. Leg gussets are to be welded to the underside of tables, and sinks, and reinforced.
4. Feet shall be stainless steel adjustable bullet shape, fully enclosed, and fit tightly to the leg. Provide 1-inch up and down adjustment from the central position, at no time exposing any threads. Adjustments are to be easily made by hand without the use of tools.
5. Legs for cabinet bases shall be 6 inches high, including feet.
6. Freestanding sinks shall be supported on legs and feet as specified, with bracing from front to rear only.
7. Where flanged feet are specified, provide stainless steel 1-5/8-inch diameter adjustable flanged foot inserts with mounting holes that can be securely fastened to the floor.

2.3.9 Casters,

Where specified, stainless steel swivel plate type. Provide gray 5-inch polyurethane wheels with 1-1/4-inch tread, leakproof Zerk grease fittings and seals, and a 250-pound capacity. Front casters shall be provided with locking brakes.

2.4 FINISHES

- A. Paint and coatings shall be of an NSF-approved type suitable for use in conjunction with foodservice equipment. Such paint or coating shall be durable, non-toxic, non-dusting, non-flaking, and mildew resistant; shall comply with all governing regulations; and shall be applied in accordance with the recommendations of the manufacturer.
- B. All exterior, galvanized parts, exposed members of a framework, and wrought steel pipe where specified to be painted shall be cleaned, properly primed with rust-inhibiting primer, degreased, and finished with two (2) coats of epoxy-based grey hammer tone paint, unless otherwise specified.
- C. Stainless steel, where exposed, shall be polished to a #4 commercial finish. Where unexposed, the finish shall be #2B. The grain of polishing shall run in the same direction wherever possible. Where surfaces are disturbed by the fabricating process, such surfaces shall be finished to match adjacent undisturbed surfaces.
- D. Fabricated equipment shall be spray-coated with plastic suitable for

protecting the equipment during transport and installation. The coating shall be easily removable and shall be removed after the equipment installation is complete at the work site, or, alternately, when directed by the Architect.

- E. Exposed surfaces on brass, bronze, or steel shall be plated with chromium over nickel in accordance with Federal Specification WW-P-541, Paragraph 9.5 and Table 9.4, unless otherwise specified.

2.5 WALK-IN REFRIGERATION UNITS

- A. Products manufactured by Kolpak, Thermokool, Bally and American Panel, or approved equal, modified to comply with specifications, are acceptable.
- B. Walk-in refrigeration units shall be partitioned into compartments, sizes, and configurations as shown in the drawings. Units to be 9'-6" overall height.

2.5.1 Panels:

- 1. Comply with Class 1 panel construction, including full corner testing of the manufacturer's constructed panels.
- 2. Insulation: 4-inch thick "Foamed-In-Place" polyurethane, expanded with R1416 and with no CFCs used. Foam shall be a 95 percent closed cell with a 2.25- pound density. The door will have the same type of insulation.
- 3. Insulation: Flame spread index of 25 or less and a smoke-developed index of not more than 450 when tested in a minimum 4-inch thickness.
- 4. Wall panel, floor, and ceiling intersections: Secure by cam lock fasteners. Floor and ceiling panels shall span the full width of the box if possible. Otherwise, stagger joints so there are no common "four corner" intersections and no joints occurring in doorways.
- 5. Interior corners: Coved.
- 6. Reinforce ceiling panels where the evaporator coil is located.
- 7. Floor panels: Load rating of 600 pounds per square foot.
- 8. Floor panels: Load rating of 1000 per square foot rolling weight.

2.5.2 Doors:

- 1. Door: 36 inches by 80 inches high.
- 2. Hinge as shown on drawings.
- 3. In-fitting type or flush-mounted. Metal clad, finish matching the exterior finishes of the box. Provide smooth corner seams.
- 4. Provide with a foot pedal door opener.
- 5. Provide aluminum treadplate kickplates and jamb guards on the interior and exterior of the door.

6. Provide a lift-cam hinge equipped with an adjustable hydraulic door closer. Mount the door closer on the exterior side of the door and adjust the closing speed at installation as required. Provide the door with a safety release inside the latch and hardware for locking with a padlock. Hinges, latches, and hardware shall be chrome plated with a satin aluminum finish. Provide a minimum of three (3) hinges per door.
7. Construct door jamb and outer door edge surfaces of stainless steel. Plastic composition material shall not be accepted. Provide anti-sweat heater cables in the door jamb to prevent condensation and frost formation.
8. Provide the door with a panic switch, motion detector, battery backups, dry contacts, and thermostatically controlled heater wires.
9. The bottom of the door shall contain a full-width adjustable rubber wiper gasket.
10. Provide each door with a 14-inch by 14-inch observation window with a heated frame and glass; triple pane glass with sealed air spaces between panes; removable for easy replacement.
11. Provide electrically heated pressure relief vents as necessary.
12. Provide one set of flexible swinging doors at each door entrance, sized to suit the opening. Doors to be suitable for temperatures as low as -20 degrees F and constructed of minimum 0.080-inch clear PVC with rounded edges. Swinging doors shall be supported on the sides of the door opening with mounting hardware on the inside of each walk-in refrigeration section. Hinges shall have a hold-open feature when the door is opened over 90 degrees. Provide anti-curl strips. Impact plate is to be provided on the front side of the door. Products manufactured by Curtron and Kason, modified to comply with specifications, are acceptable.

2.5.3 Finishes:

1. Exterior panels: 0.040-gauge pebble embossed aluminum.
2. Interior panels: 0.040-gauge pebble embossed aluminum with a white baked-on polyester finish.
3. Ceiling panels: 0.040-gauge pebble embossed aluminum with a white baked-on polyester finish.
4. Exposed exterior panels: 0.040-gauge pebble embossed aluminum with a white baked-on polyester finish.
5. Exposed exterior: 48" high Wainscot - Aluminum Treadplate
6. Floor panels: Smooth 14-gauge galvanized steel to be covered with rubber flooring. The floor will have NO wood and will be installed after walk-in box and refrigeration work is complete. The rubber floor will be provided by independent contractor but will be coordinated with Kolpak or pre-approved equal installer. The color of floor to be selected by Architect. Provided 8 inch rubber cove base up the wall and cap off with stainless steel trim. Flooring shall make a smooth transition into the walk-in refrigeration compartment.

2.5.4 Accessories:

1. Thru ceiling electrical
2. Rack, two-tier.

2.5.5 Lights:

1. Furnish each compartment complete with LED globe-type light fixture at the door, with a shatterproof protective cover, and mounted and pre-wired to switch with a pilot light in the door section.
2. Provide each walk-in refrigeration section with flush-mounted light switches on the outside of the section.
3. Provide an occupancy sensor that turns off lights after 15 minutes of inactivity.
4. Light fixtures: UL listed for wet and damp areas and capable of withstanding temperatures as low as -40 degrees F.
5. Provide additional compact-size flush-mounted LED light fixtures (Kason 1809 LED) in the quantities needed to achieve a minimum of 10-foot candles at 30 inches above the finished floor.
6. Light bulbs are to be furnished and installed by the Food Service Equipment Contractor.
7. Light fixtures manufactured by Component Hardware, Lithonia Lighting, Hubbell Lighting, and Kason, modified to comply with specifications, are acceptable.

2.5.6 Digital Thermometer

Provide a flush-mounted digital thermometer near the entry door on the exterior of each section. Thermometer to be a minimum of 2-1/2-inch diameter and have a rust-resistant case. Mount at eye level.

2.5.7 Recessed Slab

Install the walk-in refrigeration unit on a recessed concrete slab provided by the General Contractor as detailed in drawings. Supply a vapor barrier between the slab and the prefab floor. Laser level slab or use leveling medium as required for a completely level installation surface.

2.5.8 Trim

1. Where units are adjacent to walls or columns, provide trim matching the exterior finish to close spaces between the unit and adjacent building surfaces. Fasten trim on 12 inch maximum centers in a neat and workmanlike manner. All crevices shall be sealed with a clear NSF-approved sealant.
2. Furnish panels matching the exterior finish to close the area between the top of the unit and the ceiling. Provide removable panels as required for maintenance access to the top of the unit.

2.5.9 Utility Sleeves

Provide sleeves properly located for utility entrances, drain lines, and refrigeration lines. After lines are installed, fill sleeves with spray foam compound suitable for use in refrigerated spaces. Seal all penetrations.

2.6 REMOTE REFRIGERATION SYSTEM

- A. Remote refrigeration system to be provided by the same manufacturer providing walk-in refrigeration units.
- B. The balanced remote refrigeration system for the specified walk-in units will be capable of maintaining the required temperature for each section as follows:
 - 1. Cooler: 34-degree F to 38 degrees F
 - 2. Freezer: -10 degrees F to 0 degrees F
- C. Remote refrigeration system locations shown on foodservice drawings are for informational purposes only. Actual location to be coordinated and verified with architectural and structural drawings and site conditions.
- D. Remote refrigeration units are to be located in the mechanical yard and stacked using condensing unit racks. The actual location is to be coordinated with the architectural plans and building structure in keeping with all requirements of the specifications.

2.6.1 Refrigeration Piping:

- 1. FSEC shall verify and confirm the length of the refrigeration line runs between each condensing unit and evaporator coil with actual field conditions and refrigeration manufacturer prior to installation. The basis of the design assumes a refrigeration line run (horizontal plus vertical) of no more than 100-feet.
- 2. Piping shall be dehydrated refrigeration hard copper tubing conforming to ASTM B280. Piping shall be brazed with silicone solder only. Connections must be brazed using silver-alloy type filler metals meeting AWS A5.8/A5.8M classification BCuP5.
- 3. Dry nitrogen must be purged through piping at very low pressure to prevent oxidation and scaling during brazing.
- 4. Fittings shall be used for all ells and tees and shall conform to ANSI Standard B18.22.
- 5. Size suction lines for a velocity of 500-700 FPM on horizontal runs. Size vertical runs for a velocity of 1,000-1,500 FPM with properly installed (shallow) "P" traps not spaced over 8'-0" apart on all tubing risers.
- 6. Size liquid lines for a maximum 2 PSIG pressure drop.
- 7. Pressurize and leak test the entire system at not less than 100 PSIG, clean and dehydrate by maintaining a vacuum of 50 microns for a five-hour period. Add required charge of refrigerant, and oil if

necessary, and test entire system for performance. Mark each system clearly as to refrigerant type used.

2.6.2 Condensing Units:

1. Provide air-cooled condensers with a direct-driven condenser fan arranged for horizontal airflow.
2. Scroll motor compressors with built-in overload protection shall be provided.
3. Provide heavy-gauge housing for outside use.
4. Provide refrigerant receiver with inlet, outlet, purge, relief, and charging valves.
5. Provide suction and discharge line vibration eliminators.
6. Provide defrost, low-ambient pressure, starting, as well as safety operating controls. Safety controls shall include:
 - a. High-pressure cut-out with manual reset.
 - b. Magnetic control for the motor compressor with ambient compensated manual reset overloads.
 - c. Automatic recycling, low-pressure cut-out switch. The low ambient control system will be fully automatic and will not require auxiliary heat or heated receivers.
 - d. High-temperature alarm. Each alarm is to have a dry contact for wiring to a central or remote control point.
7. Furnish a one-tier metal angle iron compressor rack sized to suit compressors and located to provide full access for maintenance.

2.6.3 Evaporator Coils:

1. Each evaporator coil will be of copper tube, aluminum-finned constructions housed in a heavy-gauge aluminum casing. Provide high efficiency and high strength fan guard. Evaporator coils are to be accessed for maintenance from the front.
2. Fan blades shall be one-piece construction. There shall be no noticeable vibration.
3. Evaporators to be compatible with refrigerant provided.
4. Provide a positively sloped, hinged drain pan and universal drain fitting.

2.6.4 Demand Defrost:

1. The refrigeration system of the walk-in units will be equipped with a demand frost electronic control system mounted to the evaporator coils. The system shall control an electric expansion valve in response to the evaporator superheat and return air temperature.
2. No power wiring shall be required between evaporator coils.

3. Medium temperature application shall be pre-set at 35-degree F cut-out with air defrost. Low-temperature application shall be pre-set at -10 degrees F cut-out with demand and defrost. The cut-in temperature differential shall be 5 degrees. Adjust these setpoints at the job site if different settings are desired by the Owner.

2.6.5 Condensate Drains

In walk-in units, condensate drain lines shall be of type "L" copper tubing and directed outside the unit into a floor drain where shown on drawings. Provide condensate drain lines directed to the lowest possible level. Wrap condensate drain lines in the freezer section with electrically heated cable tape.

2.6.6 Specialty Items

Provide the system with the following specialty items:

1. Refrigerant sight glass and moisture indicator.
2. Hermetically sealed refrigerant-filter dehydrator.
3. Liquid solenoid valve.
4. Thermostatic expansion valve.
5. Heat exchanger.
6. Suction strainer and 1/2-inch pre-molded foamed plastic insulation for suction lines.

2.6.7 Required Accessories

Provide refrigeration systems with all required refrigerant piping, insulation, vibration eliminator, solenoid(s), dryer, suction line filter, expansion valve(s), thermostat(s), heat exchangers, defrost timers, etc. as necessary for complete installation. Provide pump down control circuit consisting of thermostat and solenoid valve. All components including piping and insulation to be installed using accepted industry standards, manufacturer's instructions, and first-class workmanship.

2.7 MISCELLANEOUS ACCESSORIES

2.7.1 Water Filters

Provide water filters confirmed to be compatible with the water quality and pressure on site for all ice-making equipment, hot and cold beverage equipment, dishwashing, and steamer/combi-ovens. All filter units are to be provided with shut-off valves and quick-change filters.

2.7.2 Pass-Thru Enclosures:

Provide 20-gauge stainless steel trim to fill in wall openings at pass-thru cabinets. Trim shall overlap the wall by approximately 2 inches and be within ½ inch of the cabinets on each side. Provide a 3-inch opening for air circulation at the top of the cabinet.

2.7.3 Automatic Ignition:

All gas-fired equipment shall have automatic ignition. Where required, all gas equipment shall be furnished with a safety pilot and one hundred percent safety cut-off.

2.7.4 Stainless steel Panels:

1. Install Type I exhaust hoods with clearance to combustibles of not less than 18 inches. Unless specified otherwise, provide 20-gauge stainless steel wall and ceiling panels extending 18 inches in all directions from all type I exhaust hoods specified in the "Food Service Equipment Schedule." Panels to be 304 series stainless steel with a No. 3 finish. Verify ceiling panel sizes and locations with Architect's reflected ceiling plan.
2. Wall panels to be 48 inches wide with vertical grain. Where vertical joints occur, provide stainless steel trim strip with hidden fasteners. All panels must be sealed to the wall with clear NSF-approved sealant and held in place at the edges with stainless steel screws. Provide the bottom horizontal edge of the panel with a 1- inch bend at 45 degrees to overlap the floor cove base.

2.8 LIST OF EQUIPMENT

2.8.1 Format

Provide the equipment listed except as otherwise specified as a result of the Logistical Class listed. Entries in paragraph FOOD SERVICE EQUIPMENT SCHEDULE include the following information, when applicable:

- a. Equipment Symbol.
- b. Logistical Classification.
- c. Generic description of equipment.
- d. Referenced applicable document or statement that equipment is Custom Fabricated or of Commercial design.
- e. Classification: Type, Style, Class, Size, Group, Model and Grade for equipment defined by referenced applicable document.
- f. Description for Custom Fabricated and Commercial design, and required features or accessories.
- g. Dimension: listed in order of length, width and height.
- h. Utility Requirements: Electrical: volts, hertz, phase; gas; plumbing: water, drain; listed in order.

2.8.2 Food Service Equipment [Schedule](#)

- A. Where equipment is specified by the name of manufacturer and model number, it is intended that the designated name and number represent a standard of quality and is not intended to restrict competition in any way. The Architect reserves the right to accept or reject each proposed substitution, and any construction detail or evasion of the specification requirements shall be cause for rejection. Such a

decision shall be final and binding upon all parties. Acceptance of proposed substitutions is subject to the following qualifications:

1. Equal in quality of material used, in structural strength, and in details of construction.
 2. Equal in performance and productivity.
 3. Equal in the finish or in characteristics permitting specified finish to be applied.
 4. Equal availability of replacement parts and maintenance service.
 5. Equal utility connection requirements.
- B. Equipment model numbers include the code *C014 as a suffix. This code is known as the Specifier Identification System. It is not to be removed by the bidders. Its purpose is to identify the specifier to the contractors providing the equipment in the event it is necessary to communicate questions, clarifications, and/or comments. It is to be used in all correspondence when communicating with manufacturer representatives and factories.
- C. Refer to the Foodservice Equipment Plan for the location of equipment:
- 2.8.2.1 1. AIR CURTAIN
- a. Berner Model No. SHD07-2072A*C014
 - b. Air Curtain, 72" long, unheated, (2) 3/4 hp motor, for doors up to 7 feet high, specify exterior, indoor or exterior mounting, cULus, UL EPH Classified.
 - c. Provide unit with the following:
 - 1) 9503SD020-P Automatic Door Switch, plunger type, activates air door when the door opens, single phase only & max. amp draw of 20 amps.
 - 2) White powder coat exterior finish.
 - d. Products manufactured by Mars & Curtron, modified to comply with specifications, are acceptable.

2.8.2.2 2. WALK-IN COOLER - PRODUCE COOLER

- a. Kolpak
- b. Reference Section 2.5 Walk-in Refrigeration Units
- c. (Item No. 2.1) Cooler Evaporator, Kolpak Model No. KAM26-073-1ECAFOEM-PR-4 115/60/1, R404A, Medium Temp, Air Defrost, Standard Unit Cooler, Tru-Dmnd™ by ArcticFox™, Amps: 1.6
- d. (Item No. 2.2) Cooler Condenser, Kolpak Model No. KPC69MZOP-3E 208-230/60/3, 3/4HP, R404A, Pre-Charged, Air-Cooled, Scroll, Medium Temp Standard Compressor Unit, Amps: 5.9, Ambient Temperature: 101, Amps: 5.9, Ambient Temperature: 101

2.8.2.3 3. WALK-IN COOLER - DAIRY & COOKS COOLER

- a. Kolpak
- b. Reference Section 2.5 Walk-in Refrigeration Units
- c. (Item No. 3.1) Cooler Evaporator, Kolpak Model No. KAM26-094-1ECAFOEM-PR-4 115/60/1, R404A, Medium Temp, Air Defrost, Standard Unit Cooler, Tru-Dmnd™ by ArcticFox™, Amps: 1.6
- d. (Item No. 3.2) Cooler Condenser, Kolpak Model No. KPC69MZOP-3E 208-230/60/3, 3/4HP, R404A, Pre-Charged, Air-Cooled, Scroll, Medium Temp Standard Compressor Unit, Amps: 5.9, Ambient Temperature: 100, Amps: 5.9, Ambient Temperature: 100

2.8.2.4 4. WALK-IN COOLER - THAW COOLER

- a. Kolpak
- b. Reference Section 2.5 Walk-in Refrigeration Units
- c. (Item No. 4.1) Cooler Evaporator, Kolpak Model No. KAM26-094-1ECAFOEM-PR-4 115/60/1, R404A, Medium Temp, Air Defrost, Standard Unit Cooler, Tru-Dmnd™ by ArcticFox™, Amps: 1.6
- d. (Item No. 4.2) Cooler Condenser, Model No. KPC69MZOP-3E 208-230/60/3, 3/4HP, R404A, Pre-Charged, Air-Cooled, Scroll, Medium Temp Standard Compressor Unit, Amps: 5.9, Ambient Temperature: 100, Amps: 5.9, Ambient Temperature: 100

2.8.2.5 5. WALK-IN FREEZER

- a. Kolpak
- b. Reference Section 2.5 Walk-in Refrigeration Units
- c. (Item 5.1) Freezer Evaporator, Kolpak Model No. KEL26-105-2ECAFOEM-PR-4208-230/60/1, R404A, Low Temp, Electric Defrost, Standard Unit Cooler, Tru-Dmnd™ by ArcticFox™, Amps: 9.8
- d. (Item 5.2) Freezer Condenser, Kolpak Model No. KPC299LZOP-3E208-230/60/3, 3HP, R404A, Pre-Charged, Air-Cooled, Scroll, Low Temp Standard Compressor Unit, Amps: 12.3, Ambient Temperature: 101, Amps: 12.3, Ambient Temperature: 10

2.8.2.6 6. COLD STORAGE SHELVING

- a. Metro Model No. NK4 SERIES*C014
- b. Provide shelving units comprised of the following with (4) shelves each:
 - 1) Metro Model No. 2160NK4
 - 2) (Item No. 6.1) Metro Model No. 2154NK4
 - 3) (Item No. 6.2) Metro Model No. 2148NK4
 - 4) (Item No. 6.3) Metro Model No. 2142NK4

- c. 74PK4 Post, 74-1/2"H, adjustable leveling bolt, posts are grooved at 1" increments & numbered at 2" increments, double grooved every 8".
- d. "S" clips are allowed at inner corners only.
- e. Where the shelf is below the evaporator coil, adjust the height.
- f. Verify dimensions in the field and coordinate with the shelving unit and walk-in supplier to ensure a proper fit. Provide shelving with standard finish and accessories necessary for a complete installation.
- g. Products manufactured by Eagle & Quantum, modified to comply with specifications, are acceptable.

2.8.2.7 7. CANTILEVERED SHELVING

- a. Channel Model No. TT2448*C014
- b. Provide shelving units comprised of the following:
 - 1) Shelving, Cantilever Shelving, Tubular, 48"W x 24"D x 72"H, Aluminum Construction, (900) lb. distributed weight capacity per shelf, NSF, Cross Supports (set of 2), Left (CSURL), Right (CSURC) and Common (CSURR).
 - (a) CSURL Shelving, Upright - Left, 72"H, Aluminum Construction.
 - (b) CSURR Shelving, Upright - Right, 72"H, Aluminum Construction.
 - (c) CSH48 Shelving, Cross Supports & Hardware, 48"W x 1"D x 3"H, Aluminum Construction.
 - 2) (Item No. 7.1) Channel Model No. TT2436, Shelving, Cantilever Shelving, Tubular, 36"W x 24"D x 72"H, Aluminum Construction, (900) lb. distributed weight capacity per shelf, Cross Supports (set of 2), Left (CSURL), Right (CSURC) and Common (CSURR).
 - (a) CSURL Shelving, Upright - Left, 72"H, Aluminum Construction.
 - (b) CSURR Shelving, Upright - Right, 72"H, Aluminum Construction.
 - (c) CSH36 Shelving, Cross Supports and Hardware, 36"W x 1"D x 3"H, Aluminum Construction.
- c. Verify dimensions in field and coordinate with shelving unit to ensure a proper fit. Provide shelving with standard finish and accessories necessary for a complete installation.
- d. Products manufactured by Eagle modified to comply with specifications, are acceptable.

2.8.2.8 8. MOPSINK W/ SINK FAUCET

- a. By Plumbing

2.8.2.9 9. WALL-MOUNTED MOP HANGER

- a. Eagle Group Model No. 321561*C014

- b. Mop Holder, 24"W, holds (4) mops.
- c. Products manufactured by Advance Tabco & John Boos, modified to comply with specifications, are acceptable.

2.8.2.10 10. CHEMICAL STORAGE SHELVING

- a. Metro Model No. NK4 SERIES*C014
- b. Provide shelving units comprised of the following:
 - 1) Metro Model No. 1442NK4, Shelf, wire, 42"W x 14"D, NSF.
 - 2) (Item No. 10.1) Metro Model No. 1436NK4, Shelf, wire, 36"W x 14"D, NSF.
- c. 74PK4 Post, 74-1/2"H, adjustable leveling bolt, posts are grooved at 1" increments & numbered at 2" increments, double grooved every 8".
- d. Verify dimensions in field and coordinate with shelving unit to ensure a proper fit. Provide shelving with standard finish and accessories necessary for a complete installation.
- e. Products manufactured by Eagle & Quantum, modified to comply with specifications, are acceptable.

2.8.2.11 13. DRY STORAGE SHELVING

- a. Metro Model No. NK4 SERIES*C014
- b. Provide shelving units comprised of the following with (5) shelves each:
 - 1) Metro Model No. 2460NK4, Shelf, wire, 60"W x 24"D, NSF
 - 2) (Item No. 13.1) Metro Model No. 2454NK4
 - 3) (Item No. 13.2) Metro Model No. 2448NK4
 - 4) (Item No. 13.3) Metro Model No. 2442NK4
 - 5) (Item No. 13.4) Metro Model No. 2436NK4
 - 6) (Item No. 13.5) Metro Model No. 2160NK4
- c. 86PK4 Post, 86-1/2"H, adjustable leveling bolt, posts are grooved at 1" increments & numbered at 2" increments, double grooved every 8".
- d. "S" clips are allowed at inner corners only.
- e. Verify dimensions in field and coordinate with shelving unit to ensure a proper fit. Provide shelving with standard finish and accessories necessary for a complete installation.
- f. Products manufactured by Eagle & Quauntum, modified to comply with specifications, are acceptable.

2.8.2.12 14. CAN RACK

- a. Channel Model No. CSR-9M*C014
- b. Can Rack, Full Size - Mobile, Standard Series, 25.5"W x 35"D x 82.25"H, Aluminum Construction, (162) #10 Cans or (216) #5 Cans, (2) 5" Swivel & (2) 5" Rigid Stem Casters NSF.
- c. Provide unit with the following:
 - 1) PB Accessories, Perimeter Bumper.
 - 2) 052 Accessories, 5" X 2" Heavy-Duty Caster.
- d. Products manufactured by Eagle & Lakeside, modified to comply with specifications, are acceptable.

2.8.2.13 15. SODA SYSTEM RACK & CARBONATOR

- a. By Product Supplier

2.8.2.14 16. HAND SINK

- a. Advance Tabco Model No. 7-PS-95*C014
- b. Hand Sink, pedestal mounted base, 14" wide x 10" front-to-back x 5" deep bowl, 20 gauge 304 stainless steel, splash mounted faucet, soap & paper towel dispenser, pedal valves with easy access design, basket drain, wall bracket, NSF, cCSAus.
- c. Provide unit with the following:
 - 1) 7-PS-17 Welded Side Splash, 7-3/4"H (installed height), both sides, splash mounted faucets.
- d. Products manufactured by Eagle & John Boos, modified to comply with specifications, are acceptable.

2.8.2.15 17. SERVICE FAUCET

- a. T&S Brass Model No. B-0674-BSTR*C014
- b. Service Sink Faucet, 8" centers, 4-3/4" from wall to center of outlet, built in screwdriver stops, rough chrome-plated finish, vacuum breaker nozzle with pail hook & 3/4" garden hose thread.
- c. Products manufactured by Krowne and Fisher, modified to comply with specifications, are acceptable.

2.8.2.16 18. REACH-IN REFRIGERATOR

- a. Continental Model No. 2REN*C014
- b. Refrigerator, reach-in, 57"W, two-section, self-contained refrigeration, stainless steel front, aluminum interior & ends, standard depth, full-height solid doors, cylinder locks, electronic control with digital display, hi-low alarm, unit comes standard with expansion valve, electric condensate evaporator, R290 hydrocarbon refrigerant, 1/4 HP, cETLus, NSF.

- c. Provide unit with the following:
 - 1) (2 each) 50-P008A-E Universal Pan Slide Assembly
- d. Products manufactured by True & Delfield, modified to comply with specifications, are acceptable.

2.8.2.17 19. PREP TABLE W/ SINK

- a. Atlanta Custom Fabricator
- b. Provide fabricated, stainless steel Prep Table w/ Sink, size and shape as shown on Drawings. Provide one drawer and undershelf.
- c. Where shown on Drawings, cut out top to accommodate a one compartment sink. Sink compartment to be 20"x20"x12" deep. Provide lever waste for each sink compartment as described under "Fabricated Metal Equipment". Paint exposed copper drain lines silver to match stainless steel table.
- d. Where adjacent to wall provide with a typical 8 inch high backsplash with 2 inch turnback on 45 degree angle with enclosed welded ends. Front and sides to have marine edge. Refer to Drawing for typical tabletop construction details.
- e. (Item No. 19.1) T&S Brass B-0231-CR-KIT Pantry Faucet, T&S Brass B-0231-CR-KIT Pantry Faucet, double, wall mount, 8" centers, 12" swing nozzle, lever handles, stream regulator tip, quarter-turn Cerama cartridge, low lead, (2) 24" flex hose, 1/2" NPT, NSF, ADA Compliant
- f. T&S Brass B-0199-01 Aerator, non-splash, 55/64" -27 female aerator threads, fits goosenecks & nozzles
- g. Reference the listing of approved fabricators in Section 2.3; Fabricated Metal Equipment of this specification.

2.8.2.18 20. WALL SHELF

- a. Atlanta Custom Fabricator
- b. Provide fabricated 16-gauge, stainless steel Wall Shelf. Wall Shelf to be size and shape as shown on drawings.
- c. Refer to Elevation Drawings for mounting height.
- d. Shelf sides and rear to flange up 2". Front to have 1-1/2" rolled down edge. Support Shelf on wall by heavy gauge stainless steel brackets or by approved alternate means.
- e. Reference the listing of approved fabricators in Section 2.3; Fabricated Metal Equipment of this specification.

2.8.2.19 23. REACH-IN REFRIGERATOR

- a. Continental Model No. 2REN*C014
- b. Refrigerator, reach-in, 57"W, two-section, self-contained refrigeration, stainless steel front, aluminum interior & ends, standard depth, full-height solid doors, cylinder locks, electronic

control with digital display, hi-low alarm, unit comes standard with expansion valve, electric condensate evaporator, R290 hydrocarbon refrigerant, 1/4 HP, cETLus, NSF.

- c. Provide unit with the following:
 - 1) (2 each) 50-P008A-E Universal Pan Slide Assembly
- d. Products manufactured by True & Delfield, modified to comply with specifications, are acceptable.

2.8.2.20 24. WORKTABLE

- a. Atlanta Custom Fabricator
- b. Provide fabricated, stainless steel Worktable, size and shape as shown on Drawings. Provide right end step down, one drawer and undershelf.
- c. Where adjacent to wall provide with a typical 8 inch high backsplash with 2 inch turnback on 45 degree angle with enclosed welded ends. Front and sides to have rolled edge. Refer to Drawing for typical tabletop construction details.
- d. Reference the listing of approved fabricators in Section 2.3; Fabricated Metal Equipment of this specification.

2.8.2.21 25. MIXER

- a. Hobart Model No. HL200-1*C014
- b. Mixer - Unit Only, Bench, 20 quart, (3) fixed speeds plus stir speed, gear- driven transmission, 15-minute SmartTimer™, #12 taper hub, manual bowl lift, stainless steel bowl guard, 1/2 hp, cord with plug.
- c. Provide unit with the following:
 - 1) BOWL-HL20P Mixer Bowl, 20-quart, stainless steel.
 - 2) SCRAPER-HL20 Bowl Scraper for 20-quart bowl & mounting bracket.
 - 3) SPLASH-LEX020 Mixer Bowl Splash Cover, Lexan.
- d. Products manufactured by Globe & Varimixer, modified to comply with specifications, are acceptable.

2.8.2.22 26. WALL SHELF

- a. Atlanta Custom Fabricator
- b. Provide fabricated 16-gauge, stainless steel Wall Shelf. Wall Shelf to be size and shape as shown on drawings.
- c. Refer to Elevation Drawings for mounting height.
- d. Shelf sides and rear to flange up 2". Front to have 1-1/2" rolled down edge. Support Shelf on wall by heavy gauge stainless steel brackets or by approved alternate means.

- e. Reference the listing of approved fabricators in Section 2.3; Fabricated Metal Equipment of this specification.

2.8.2.23 27. UNIVERSAL PAN RACK

- a. New Age Model No. 1306*C014
- b. Rack, mobile, universal, open frame design, square tube construction, (20) universal slides, 3" centers, all-welded aluminum construction, end loading, slides for 12" x 20", 18" x 26" & 13" 18" pans, 3-1/4" wide runners, (4) 5" platform casters, NSF.
- c. Products manufactured by Advance Tabco & Eagle, modified to comply with specifications, are acceptable.

2.8.2.24 28. BLAST CHILLER / SHOCK FREEZER

- a. American Panel Model No. AP10BCF100-2*C014
- b. Blast Chiller/Shock Freezer, Reach-in, self-contained, (10) 12" x 20" x 2.5" pan capacity, 100 lbs. from 160° F to 38° F blast chill capacity/90 minutes, 60 lbs. 160° F to 0° Freeze capacity/240 minutes, 7" LCD touch screen controller with Quick Start & A La Carte functionality, (1) heated food probe, stainless steel interior & exterior, 6" stainless steel legs, 1-1/2 HP, UL CLASSIFIED EPH, cUL, ANSI/NSF.
- c. Provide unit with the following:
 - 1) Drain line assembly
 - 2) Condensate evaporator
 - 3) Wi-Fi Communications
 - 4) 5" Casters
- d. Products manufactured by Traulsen & Delfield, modified to comply with specifications, are acceptable.

2.8.2.25 29. ICE MACHINE

- a. Hoshizaki Model No. KMD-860MAJ*C014
- b. Ice Maker, Cube-Style, 30"W, air-cooled, self-contained condenser, production capacity up to 855 lb/24 hours at 70°/50° (665 lb AHRI certified at 90°/70°), stainless steel finish, crescent cube style, R-404A refrigerant, NSF, UL
- c. Provide unit with the following:
 - 1) (Item No. 29.1) Ice Bin B-500SF Ice Bin, 30"W, top-hinged front-opening door, 500-lb ice storage capacity, for top-mounted ice maker, stainless steel exterior, painted legs included, protected with H- GUARD Plus Antimicrobial Agent, ETL, ETL-Sanitation.
 - 2) HS-2129 Top kit extension
 - 3) LP-6 Leg Package

- 4) HS-5607 Scoop Holder Kit
- 5) H9320-52 Water Filtration System

d. Products manufactured by Manitowoc & Scotsman, modified to comply with specifications, are acceptable.

2.8.2.26 30. ICE MACHINE

- a. Hoshizaki Model No. KMD-860MAJ*C014
- b. Ice Maker, Cube-Style, 30"W, air-cooled, self-contained condenser, production capacity up to 855 lb/24 hours at 70°/50° (665 lb AHRI certified at 90°/70°), stainless steel finish, crescent cube style, R-404A refrigerant, NSF, UL
- c. Provide unit with the following:
 - 1) (Item No. 30.1) Ice Bin B-700SF Ice Bin, 44"W, top-hinged front-opening door, 700-lb ice storage capacity, for top-mounted ice makers, stainless steel exterior, painted legs included, protected with H- GUARD Plus Antimicrobial Agent, ETL, ETL-Sanitation.
 - 2) HS-2034 Top Kit, 14", ABS
 - 3) HS-2130 Top kit extension
 - 4) LP-6 Leg Package
 - 5) HS-5607 Scoop Holder Kit
 - 6) H9320-52 Water Filtration System
- d. Products manufactured by Manitowoc & Scotsman, modified to comply with specifications, are acceptable.

2.8.2.27 31. FLOOR TROUGH

- a. Atlanta Custom Fabricator
- b. Provide fabricated 14-gauge, stainless steel Floor Trough with brushed satin finish. Floor Trough to be size and shape as shown on drawings, 4" deep with steel anchor rods placed approximately 12" O.C.
- c. Provide unit with the following:
 - 1) 6-1/2-inch diameter holes for drain assembly with 4" O.D. tailpiece and removable stainless steel perforated basket.
 - 2) Extruded polymer slip-proof grating.
- d. Reference the listing of approved fabricators in Section 2.3; Fabricated Metal Equipment of this specification.

2.8.2.28 33. PASS THRU HEATED CABINET

- a. Continental Model No. DL1WE-SS-GD-PT-MOD*C014

- b. Heated Cabinet, extra wide pass-thru, one-section, 22 cu. ft. capacity, (3) shelves, stainless steel exterior & interior, standard depth, hinged doors, electronic control with digital display, hi-low alarm, cETLus, NSF.
- c. Provide unit with the following:
 - 1) Doors hinged as per plan
 - 2) Controls & glass door to kitchen side
 - 3) 5" Casters
 - 4) 50-P008A-E Universal Pan Slide Assembly, full section universal slides for 18 x 26 or (2) 12 x 20 pans on 5" centers, bottom support, stainless steel angles.
- d. Products manufactured by True & Delfield, modified to comply with specifications, are acceptable.

2.8.2.29 34. PASS-THRU REFRIGERATOR

- a. Continental Model No. D1RENSSGDPT-MOD*C014
- b. Refrigerator, pass-thru, 28-1/2"W, one-section, self-contained refrigeration, stainless steel exterior & interior, stainless steel front, standard depth cabinet, wide full-height glass door, cylinder lock, electronic control with digital display, hi-low alarm, the unit comes standard with expansion valve, 6" stainless steel legs, R290 hydrocarbon refrigerant, 1/4 HP, cETLus, NSF
- c. Provide unit with the following:
 - 1) Doors hinged as per plan
 - 2) Controls & glass door to kitchen side
 - 3) 5" Casters
 - 4) 50-P008A-E Universal Pan Slide Assembly, full section universal slides for 18 x 26 or (2) 12 x 20 pans on 5" centers, bottom support, stainless steel angles.
- d. Products manufactured by True & Delfield, modified to comply with specifications, are acceptable.

2.8.2.30 35. PREP TABLE W/ SINK

- a. Atlanta Custom Fabricator
- b. Provide fabricated, stainless steel Prep Table w/ Sink, size, and shape as shown on Drawings. Provide one drawer and undershelf.
- c. Where shown on Drawings, cut out the top to accommodate a one-compartment sink. Sink compartment to be 20"x20"x12" deep. Provide lever waste for each sink compartment as described under "Fabricated Metal Equipment". Paint exposed copper drain lines silver to match stainless steel table.

- d. Where adjacent to wall provide with a typical 8 inch high backsplash with 2 inch turnback on 45 degree angle with enclosed welded ends. Front and sides to have marine edge. Refer to Drawing for typical tabletop construction details.
- e. (Item No. 35.1) T&S Brass B-0231-CR-KIT Pantry Faucet, double, wall mount, 8" centers, 12" swing nozzle, lever handles, stream regulator tip, quarter-turn Cerama cartridge, low lead, (2) 24" flex hose, 1/2" NPT, NSF, ADA Compliant
- f. T&S Brass B-0199-01 Aerator, non-splash, 55/64" -27 female aerator threads, fits goosenecks & nozzles
- g. Reference the listing of approved fabricators in Section 2.3; Fabricated Metal Equipment of this specification.

2.8.2.31 36. WALL SHELF

- a. Atlanta Custom Fabricator
- b. Provide fabricated 16-gauge, stainless steel Wall Shelf. Wall Shelf to be size and shape as shown on drawings.
- c. Refer to Elevation Drawings for mounting height.
- d. Shelf sides and rear to flange up 2". Front to have 1-1/2" rolled down edge. Support Shelf on wall by heavy gauge stainless steel brackets or by approved alternate means.
- e. Reference the listing of approved fabricators in Section 2.3; Fabricated Metal Equipment of this specification.

2.8.2.32 37. REACH-IN REFRIGERATOR

- a. Continental Model No. 1REN*C014
- b. Refrigerator, reach-in, 28-1/2"W, one-section, self-contained refrigeration, stainless steel front, aluminum interior & ends, standard depth, full-height solid door, cylinder lock, electronic control with digital display, hi-low alarm, unit comes standard with expansion valve, electric condensate evaporator, R290 Hydrocarbon refrigerant, 1/4 HP, CETLus, NSF.
- c. Provide unit with the following:
 - 1) Door hinged on left
 - 2) 5" Casters.
- d. Products manufactured by True & Delfield, modified to comply with specifications, are acceptable.

2.8.2.33 38. PREP TABLE W/ SINK

- a. Atlanta Custom Fabricator
- b. Provide fabricated, stainless steel Prep Table w/ Sink, size and shape as shown on Drawings. Provide two drawers and undershelves.

- c. Where shown on Drawings, cut out top to accommodate a two compartment sink. Each compartment to be 20"x20"x12" deep. Provide lever waste for each sink compartment as described under "Fabricated Metal Equipment". Paint exposed copper drain lines silver to match stainless steel table.
- d. Where shown on Drawings, there shall be a pre-rinse sink. Cut-out waste to accommodate collar adapter of Disposer, Item No. 39. Over throat opening of disposer fabricate and install a removable stainless steel conical cover. Cover to set on stainless steel bands and have 2" clearance for waste to enter. Diameter to overlap throat opening by 1". Weld Sink collar adapter of Item No. 39, to cut-out for disposer mounting, similar to Model No. CC650, manufactured by Atlanta Custom Fabricators. Provide removable stainless steel rack guide flush with top.
- e. Where adjacent to wall provide with a typical 8 inch high backsplash with 2 inch turnback on 45 degree angle with enclosed welded ends. Front and sides to have marine edge. Refer to Drawing for typical tabletop construction details.
- f. Provide fabricated 16-gauge, stainless steel table mounted Shelf. Shelf to be size and shape as shown on drawings. Unit to be mounted and located 20" above the countertop. Rear and sides to turn up 1-1/2". Front to have a 1-1/2" rolled down edge. Support Shelf with 1-1/2" diameter stainless steel tubing.
- g. (Item No. 38.1) T&S Brass B-0231-CR-KIT Pantry Faucet T&S Brass B-0231-CR-KIT Pantry Faucet, double, wall mount, 8" centers, 12" swing nozzle, lever handles, stream regulator tip, quarter-turn Cerama cartridge, low lead, (2) 24" flex hose, 1/2" NPT, NSF, ADA Compliant
- h. T&S Brass B-0199-01 Aerator, non-splash, 55/64" -27 female aerator threads, fits goosenecks & nozzles
- i. Reference the listing of approved fabricators in Section 2.3; Fabricated Metal Equipment of this specification.

2.8.2.34 39. DISPOSER

- a. Salvajor Model No. 200-SA-3-WSP*C014
- b. Disposer, Sink Assembly, 3-1/2" sink collar, 2 Hp motor, start/stop push button, drain/flush/time delay, automatic reversing & water saving with safety line disconnect ARSS-LD control, includes fixed nozzle, chrome plated vacuum breaker, solenoid valve, sink stopper & flow control, heat treated aluminum alloy housing, UL, CSA, CE.
- c. Provide unit with the following:
 - 1) 208v/60/3-ph, 6.6 amps.
 - 2) DP Stainless steel dejamming prong.
 - 3) Omit vacuum breaker and provide B0455-04, manufactured by T &S Brass and Bronze Works.
- d. Products manufactured by Hobart & InsinkErator, modified to comply with specifications, are acceptable.

2.8.2.35 40. FOOD PROCESSOR

- a. Hobart Model No. FP350-1*C014
- b. Food Processor - Unit Only, angled continuous feed design, full-size hopper, 26 lb per/min production cap., 430 rpm, stainless steel cutting surfaces, planetary gear transmission, triple safety interlocks, aluminum housing, rubber feet, UL, NSF.
- c. Products manufactured by Robo Coup & Univex, modified to comply with specifications, are acceptable.

2.8.2.36 41. MOBILE SLICER TABLE

- a. Atlanta Custom Fabricator
- b. Provide fabricated, stainless steel Work Table, size and shape as shown on Drawings. Provide with undershelf.
- c. SPECIAL WORKING HEIGHT - 31"
- d. Provide stem casters per section 2.2 M2. Front casters to be provided w/ brakes.
- e. Reference the listing of approved fabricators in Section 2.3; Fabricated Metal Equipment of this specification.

2.8.2.37 42. FOOD CUTTER

- a. Hobart Model No. 84186-1*C014
- b. Food Cutter with #12 attachment hub, 18" diameter stainless steel bowl 20 RPM, double stainless steel knives 1725 RPM, bowl cover with safety interlock, push/pull on/off switch, one-piece burnished aluminum housing, 3" legs, 6' cord with plug.
- c. Products manufactured by Univex, modified to comply with specifications, are acceptable.

2.8.2.38 43. SLICER

- a. Hobart Model No. HS7-1*C014
- b. Heavy Duty Meat Slicer, automatic, 13" CleanCut™ removable knife with removal tool, burnished finish, (3) stroke lengths, & (4) stroke speeds, removable meat grip assembly, removable ring guard cover, product fence, single action top mounted sharpener with Borazon™ stones, manual lift lever, 1/2 hp motor, NSF cETLus.
- c. Products manufactured by Globe & Berkel, modified to comply with specifications, are acceptable.

2.8.2.39 44. WORKTABLE

- a. Atlanta Custom Fabricator
- b. Provide fabricated, stainless steel Work Table, size and shape as shown on Drawings. Provide one drawer and undershelf.

- c. Where adjacent to wall provide with a typical 8 inch high backsplash with 2 inch turnback on 45 degree angle with enclosed welded ends. Front and sides to have marine edge. Refer to Drawing for typical tabletop construction details.
- d. Provide Step-down top to 24" working height.
- e. Provide fabricated 16-gauge, stainless steel table-mounted Shelf. Shelf is to be sized and shaped as shown on the drawings. Unit to be mounted and located 20" above the countertop. Rear and sides to turn up 1-1/2". Front to have a 1-1/2" rolled down the edge. Support Shelf with 1-1/2" diameter stainless steel tubing.
- f. Reference the listing of approved fabricators in Section 2.3; Fabricated Metal Equipment of this specification.

2.8.2.40 45. WORKTABLE

- a. Atlanta Custom Fabricator
- b. Provide fabricated, stainless steel Worktable, size and shape as shown on Drawings. Provide one drawer and undershelf.
- c. Where adjacent to wall provide with a typical 8 inch high backsplash with 2 inch turnback on 45 degree angle with enclosed welded ends. Front and sides to have rolled edge. Refer to Drawing for typical tabletop construction details.
- d. Provide fabricated 16-gauge, stainless steel table mounted Shelf. Shelf to be size and shape as shown on drawings. Unit to be mounted and located 20" above the countertop. Rear and sides to turn up 1-1/2". Front to have a 1-1/2" rolled down edge. Support Shelf with 1-1/2" diameter stainless steel tubing.
- e. Reference the listing of approved fabricators in Section 2.3; Fabricated Metal Equipment of this specification.

2.8.2.41 46. PREP TABLE W/ SINK

- a. Atlanta Custom Fabricator
- b. Provide fabricated, stainless steel Prep Table w/ Sink, size and shape as shown on Drawings. Provide two drawers and undershelf.
- c. Where shown on Drawings, cut out top to accommodate a two compartment sink. Each compartment to be 20"x20"x12" deep. Provide lever waste for each sink compartment as described under "Fabricated Metal Equipment". Paint exposed copper drain lines silver to match stainless steel table.
- d. Where shown on Drawings, there shall be a pre-rinse sink. Cut-out waste to accommodate collar adapter of Disposer, Item No. "47". Over throat opening of disposer fabricate and install a removable stainless steel conical cover. Cover to set on stainless steel bands and have 2" clearance for waste to enter. Diameter to overlap throat opening by 1". Weld Sink collar adapter of Item No. 47, to cut-out for disposer mounting, similar to Model No. CC650, manufactured by Atlanta Custom Fabricators. Provide removable stainless steel rack guide flush with top.

e. Where adjacent to wall provide with a typical 8 inch high backsplash with 2 inch turnback on 45 degree angle with enclosed welded ends. Front and sides to have marine edge. Refer to Drawing for typical tabletop construction details.

f. Provide fabricated 16-gauge, stainless steel table mounted Shelf. Shelf to be size and shape as shown on drawings. Unit to be mounted and located 20" above the countertop. Rear and sides to turn up 1-1/2". Front to have a 1-1/2" rolled down edge. Support Shelf with 1-1/2" diameter stainless steel tubing.

g. (Item No. 46.1) T&S Brass B-0231-CR-KIT Pantry Faucet, double, wall mount, 8" centers, 12" swing nozzle, lever handles, stream regulator tip, quarter-turn Cerama cartridge, low lead, (2) 24" flex hose, 1/2" NPT, NSF, ADA Compliant.

h. T&S Brass B-0199-01 Aerator, non-splash, 55/64" -27 female aerator threads, fits goosenecks & nozzles.

i. Reference the listing of approved fabricators in Section 2.3; Fabricated Metal Equipment of this specification.

2.8.2.42 47. DISPOSER

a. Salvajor Model No. 200-SA-3-WSP*C014

b. Disposer, Sink Assembly, 3-1/2" sink collar, 2 Hp motor, start/stop push button, drain/flush/time delay, automatic reversing & water saving with safety line disconnect ARSS-LD control, includes fixed nozzle, chrome plated vacuum breaker, solenoid valve, sink stopper & flow control, heat treated aluminum alloy housing, UL, CSA, CE.

c. Provide unit with the following:

- 1) 208v/60/3-ph, 6.6 amps.
- 2) DP Stainless steel dejamming prong
- 3) Omit vacuum breaker and provide B0455-04, manufactured by T &S Brass and Bronze Works.

d. Products manufactured by Hobart & InsinkErator, modified to comply with specifications, are acceptable.

2.8.2.43 48. UTILITY DISTRIBUTION SYSTEM

a. Accurex Model No. XMIVE-GHCO-252*C014

b. Provide Accurex Model FlexConnect UDS as shown on plans and in accordance with the following specification:

c. The FlexConnect Utility Distribution System (UDS) shall be island type. Service risers and horizontal raceway with removable access panels to be constructed of 16 ga. Type 300 series stainless steel. The service risers will be able to accommodate both electrical and plumbing. The horizontal raceway will be divided into separate compartments for plumbing and electrical. Flanged foot pedestals are

provided at each field joint on the horizontal chase.

d. Refer to drawings for all dimensions.

e. Provide watertight barrier between plumbing and electrical compartment.

f. Electrical

1) Electrical compartment shall be completely enclosed and separated from the plumbing compartment.

2) Provide 120/208V 3 Phase panel board style electrical service with all breakers end mounted, located behind a dead front with hinged door access.

3) Main breaker to be 225 amp with shunt trip or 20% over calculated load.

4) Provide status indicating light for each individual circuit breaker connection end mounted in riser.

5) All receptacles shall be mounted on removable plates on 12" centers beneath the horizontal chase.

6) Provide plug/cord sets to match electrical connections unless hard wired.

7) The unit will have light and fan toggle control switches located on the end of the electrical service riser and a covered 120/1ph.

8) 20 Amp convenience outlet on both service riser ends.

9) All 120-volt 20 amp connections shall be duplex GFCI to meet code.

10) Weatherproof covers to be supplied for all electrical connections.

g. Plumbing

1) All plumbing will have a single point connection in the plumbing riser piped from the ceiling by plumbing contractor.

2) The horizontal plumbing compartment is to include manifolds for gas, hot water, and cold water.

3) The 2-inch single gas manifold looped gas will include welded thread- o-let connections.

4) The gas connections are spaced 12 inches apart and are alternately sized as 0.75 inch and 1.25 inch every other connection.

5) Provide main quarter turn ball valve shut off and electrical solenoid gas valve for fire shutdown.

6) A manual gas reset with gas on indicator, alarm, and

emergency push button shut down to be provided for gas valve control.

7) Also include ball valves and hoses for connections to cooking equipment.

8) All unused gas drops will be capped below the chase, ready for easy connection to any cooking appliance.

9) The 1 inch hot and cold-water manifolds will include 0.75 inch plumbing drops every 24 inches along the horizontal raceway.

10) All water piping to be insulated and labeled.

11) Each water manifold will be provided with main quarter turn ball valve shut offs and pressure gauges.

12) Provide ball valves and hoses for all appliance connections where required.

13) All unused plumbing drops are capped below the chase, ready for easy connection to any cooking appliance.

14) Provide filtered water, if required rated for up to 5 gallons per minute, in the plumbing riser with manifold piping provided to appliances requiring filtered water.

15) Supply ball valves and hoses for all applicable connections.

h. It is the responsibility of FSEC and GC to coordinate and provide exhaust hood and utility distribution system from same manufacture.

i. Products manufactured by Gaylord and Halton, modified to comply with specifications, are acceptable.

2.8.2.44 49. EXHAUST HOOD

a. Accurex Model No. XBEW-240.00-S*C014

b. Accurex Exhaust Hood Model XBEW as shown on plans and in accordance with the following specification:

c. Type I, exhaust only wall low proximity canopy suitable for all types of cooking applications. The hood(s) shall be U.L. 710 Listed without a fire damper (with optional) for medium, heavy, or extra-heavy duty rated cooking appliances. Make-up air shall be independently provided. The hood(s) exterior shall be constructed of a minimum of 18 gauge 300 series stainless steel. The hood(s) shall be constructed using the standing seam method for optimum strength and with a Performance Enhancing Lip (PEL) to improve capture efficiency by turning air back into the hood. Front panels shall be of double wall construction with 1-inch insulation to add additional strength and rigidity. An integral 3-inch air space is provided to meet NFPA® 96 clearance requirements against limited combustible walls. Integral 3-inch air space may be omitted for non-combustible construction. All seams, joints and penetrations of the hood enclosure shall be welded and/or liquid tight. Lighter material gauges, alternate material types and finishes are not acceptable. All unexposed interior surfaces shall

be constructed of a minimum 18-gauge corrosion resistant stainless steel including, but not limited to ducts, plenum, and brackets. The hood(s) shall include a filter housing constructed of the same material as the hood. The filters shall be stainless steel baffle type (non-stick coating optional), U.L. 1046 Classified, and in sufficient number and size to ensure optimum performance. The filter housing shall terminate in a pitched, full length grease trough which shall drain into a removable grease container. These filters shall have a grease removal efficiency of 28% at 8 microns (16% from 3-10 microns) and static pressure drop of 0.5-0.6 inWC. Vapor proof, U.L. Listed incandescent (LED optional) light fixtures shall be pre-wired to a junction box located at the top of the hood for field connection. Wiring shall conform to the requirements of the NFPA® 70. The canopy hood(s) shall be built in accordance with the NFPA® 96, IMC, UMC, and bear the NSF Seal of Approval. The hood manufacturer shall provide, on request, the necessary data that confirms compliance with the code authorities listed above.

- d. (Item No. 49) MARK H-49 SECTION 1 - XBEW-120.00-S - 60" Deep
- e. Left Utility Fire Cabinet.
- f. (Item No. 49.1) MARK H-49.1 SECTION 2 -, XBEW-120.00-S - 60" Deep
- g. Lights - LED
- h. Ceiling Enclosures - 12 in. High on Left, Front and Right ends. KEC TO VERIFY CEILING HEIGHT.
- i. Continuous Capture - UL listed connection to join multiple sections.
- j. Controls to be provided by Mechanical Contractor
- k. Fire System - Provide factory pre-piped for Ansul R-102 fire protection system located in an integral utility cabinet on the right end of the hood (Item No.49). System shall provide surface, duct and plenum protection for items of cooking equipment located beneath the hood in accordance with all applicable codes and provisions of NFPA 17A and 96. All system piping shall be concealed where possible with exposed portions of either chrome fittings or stainless-steel sleeving. System shall be wired with shunt trip breaker and electric/gas shut-off valve serving items of cooking equipment beneath the hood to provide power and fuel shut-off in the event of system actuation.
- l. Products manufactured by Captive Aire and Gaylord, modified to comply with specifications, are acceptable.
- m. Products manufactured by Gaylor & Halton, modified to comply with specifications, are acceptable.

2.8.2.45 50. FLOOR TROUGH

- a. Atlanta Custom Fabricator
- b. Provide fabricated 14-gauge, stainless steel Floor Trough with brushed satin finish. Floor Trough to be size and shape as shown on drawings, 4" deep with steel anchor rods placed approximately 12" O.C.

c. Provide unit with the following:

- 1) 6-1/2-inch diameter holes for drain assembly with 4" O.D. tailpiece and removable stainless steel perforated basket.
- 2) Extruded polymer slip-proof grating.

d. Reference the listing of approved fabricators in Section 2.3; Fabricated Metal Equipment of this specification.

2.8.2.46 52. TILTING SKILLET

a. Cleveland Model No. SEL30TR *C014

b. Tilting Skillet, electric, 30-gallon capacity, modular open base, standard with hydraulic hand tilt with quick lowering feature, stainless steel construction, includes spring-assisted cover and gallon markings, stainless steel level, adjustable feet, UL, CE, NSF, IPX6.

c. Provide unit with the following:

- 1) PT1 Power Tilt, with hand tilt override.
- 2) TD2SK 2" tangent draw-off valve, front mounted left side.
- 3) TDDC Drain Cup Assembly, includes: 8' length of 2" ID hose, stainless steel cup assembly & hose clamp.
- 4) PCS Pan Carrier.
- 5) DKFS Double Pantry Skillet Filler, with 60" hose.
- 6) Mounting bracket.
- 7) FSSK Food Strainer

d. Utilities are furnished through Item No. 48, Utility Distribution System.

e. Products manufactured by Vulcan & Crown, modified to comply with specifications, are acceptable.

2.8.2.47 53. TILTING SKILLET

a. Cleveland Model No. SGL30TR*C014

b. Tilting Skillet, gas, 30-gallon capacity, modular open base, standard with hydraulic hand tilt with quick lowering feature, stainless steel construction, includes spring-assisted cover, gallon markings and electronic spark ignition, stainless steel level adjustable feet, CE, NSF, IPX6.

c. Provide unit with the following:

- 1) Performance start-up included at customer request after equipment is installed.

- 2) Natural Gas.
- 3) PT1 Power Tilt, with hand tilt override.
- 4) TD2SK 2" tangent draw-off valve, front mounted left side.
- 5) TDDC Drain Cup Assembly, includes: 8' length of 2" ID hose, stainless steel cup assembly & hose clamp.
- 6) PCS Pan Carrier.
- 7) DKFS Double Pantry Skillet Filler, with 60" hose.
- 8) FBSTR Faucet Bracket.
- 9) FSSK Food Strainer.

d. Utilities are furnished through Item No. 48, Utility Distribution System.

e. Products manufactured by Vulcan & Crown, modified to comply with specifications, are acceptable.

2.8.2.48 54. KETTLE

a. Cleveland Model No. KGL25T*C014

b. Kettle, gas, manual tilting, 25-gallon capacity, 2/3 steam jacket design, electronic spark ignition, solid-state control panel, floor mounted control console supports, 304 stainless steel construction with 316 series stainless steel liner, flanged feet, 50 psi rating, cover & draw-off.

c. Provide unit with the following:

- 1) Performance start-up included at customer request after equipment is installed.
- 2) Natural Gas.
- 3) TD2 2" tangent draw-off valve with strainer.
- 4) TDDC Drain Cup Assembly, includes: 8' length of 2" ID hose, stainless steel cup assembly & hose clamp.
- 5) CHS25 Spring-assisted cover.
- 6) PRSK Double Pantry Pre-Rinse Spray Hose.
- 7) FBKT Faucet Bracket.

d. Utilities are furnished through Item No. 48, Utility Distribution System.

e. Products manufactured by Vulcan & Crown, modified to comply with specifications, are acceptable.

2.8.2.49 55. KETTLE WITH STAND

- a. Cleveland Model No. KET12T*C014*C014
- b. Tilting Kettle, electric, countertop, 12-gallon (45L) capacity, 2/3 steam jacket design, self-contained, lever style tilting, anti-drip pour spout, IPX6 water protection controls, self-locking marine style safety latch, reinforced rolled rim, support console on right, stainless steel construction with 316 series stainless steel liner, 50 PSI rated.
- c. Provide unit with the following:
 - 1) Performance start-up included at customer request after equipment is installed (Free Water Quality Check included) (contact Cleveland Sales Representative for details)
 - 2) Standard Controls, temperature control/main power ON/OFF dial with 1-10 settings, LED indicators for heat-ON, low water.
 - 3) LCHE-12 Kettle Lift-Off Cover Holder, per each kettle
 - 4) CL12 Lift-Off Cover, 12 gallons, per each kettle.
 - 5) DPK27 Double Pantry Faucet and Bracket Kit.
 - 6) ST55 Equipment Stand, open base with sliding drain drawer & splash screen, 55" x 20", 18" high, stainless-steel top and legs.
 - 7) SG28 (2) Retractable splash guard/pan shelves, for drain drawer.
- d. Utilities are furnished through Item No. 48, Utility Distribution System.
- e. Products manufactured by Vulcan & Crown, modified to comply with specifications, are acceptable.

2.8.2.50 56. UTILITY CART

- a. PVI Model No. AUC2436-3*C014
- b. Utility Cart, 3-tier, 36"W x 24"D x 36"H, non-rust aluminum construction, solid adjustable shelves, corner clip assembly, 400lbs. capacity per shelf, adjustable handle assembly, swivel casters, KD, NSF.
- c. Products manufactured by Lakeside & PVI, modified to comply with specifications, are acceptable.

2.8.2.51 57. UTILITY DISTRIBUTION SYSTEM

- a. Accurex Model No. XMIVE-GHCO-252*C014
- b. Provide Accurex Model FlexConnect UDS as shown on plans and in accordance with the following specification:
- c. The FlexConnect Utility Distribution System (UDS) shall be island type. Service risers and horizontal raceway with removable access

panels to be constructed of 16 ga. Type 300 series stainless steel. The service risers will be able to accommodate both electrical and plumbing. The horizontal raceway will be divided into separate compartments for plumbing and electrical. Flanged foot pedestals are provided at each field joint on the horizontal chase.

d. Refer to drawings for all dimensions.

e. Provide watertight barrier between plumbing and electrical compartment.

f. Electrical

1) Electrical compartment shall be completely enclosed and separated from the plumbing compartment.

2) Provide 120/208V 3 Phase panel board style electrical service with all breakers end mounted, located behind a dead front with hinged door access.

3) Main breaker to be 225 amp with shunt trip or 20% over calculated load.

4) Provide status indicating light for each individual circuit breaker connection end mounted in riser.

5) All receptacles shall be mounted on removable plates on 12" centers beneath the horizontal chase.

6) Provide plug/cord sets to match electrical connections unless hard wired.

7) The unit will have light and fan toggle control switches located on the end of the electrical service riser and a covered 120/1ph.

8) 20 Amp convenience outlet on both service riser ends.

9) All 120-volt 20 amp connections shall be duplex GFCI to meet code.

10) Weatherproof covers to be supplied for all electrical connections.

g. Plumbing

1) All plumbing will have a single point connection in the plumbing riser piped from the ceiling by plumbing contractor.

2) The horizontal plumbing compartment is to include manifolds for gas, hot water, and cold water.

3) The 2-inch single gas manifold looped gas will include welded thread- o-let connections.

4) The gas connections are spaced 12 inches apart and are alternately sized as 0.75 inch and 1.25 inch every other connection.

- 5) Provide main quarter turn ball valve shut off and electrical solenoid gas valve for fire shutdown.
 - 6) A manual gas reset with gas on indicator, alarm, and emergency push button shut down to be provided for gas valve control.
 - 7) Also include ball valves and hoses for connections to cooking equipment.
 - 8) All unused gas drops will be capped below the chase, ready for easy connection to any cooking appliance.
 - 9) The 1 inch hot and cold-water manifolds will include 0.75 inch plumbing drops every 24 inches along the horizontal raceway.
 - 10) All water piping to be insulated and labeled.
 - 11) Each water manifold will be provided with main quarter turn ball valve shut offs and pressure gauges.
 - 12) Provide ball valves and hoses for all appliance connections where required.
 - 13) All unused plumbing drops are capped below the chase, ready for easy connection to any cooking appliance.
 - 14) Provide filtered water, if required rated for up to 5 gallons per minute, in the plumbing riser with manifold piping provided to appliances requiring filtered water.
 - 15) Supply ball valves and hoses for all applicable connections.
- h. It is the responsibility of of FSEC and GC to coordinate and provide exhaust hood and utility distribution system from same manufacture.
- i. Products manufactured by Gaylord and Halton, modified to comply with specifications, are acceptable

2.8.2.52 58. EXHAUST HOOD

- a. Accurex Model No. XBEW-240-S*C014
- b. Accurex Exhaust Hood Model XBEW as shown on plans and in accordance with the following specification:
- c. Type I, exhaust only wall low proximtiy canopy suitable for all types of cooking applications. The hood(s) shall be U.L. 710 Listed without a fire damper (with optional) for medium, heavy, or extra-heavy duty rated cooking appliances. Make-up air shall be independently provided. The hood(s) exterior shall be constructed of a minimum of 18 gauge 300 series stainless steel. The hood(s) shall be constructed using the standing seam method for optimum strength and with a Performance Enhancing Lip (PEL) to improve capture efficiency by turning air back into the hood. Front panels shall be of double wall construction with 1-inch insulation to add additional strength and rigidity. An integral 3-inch air space is provided to meet NFPA® 96 clearance requirements against limited combustible walls. Integral

3-inch air space may be omitted for non-combustible construction. All seams, joints and penetrations of the hood enclosure shall be welded and/or liquid tight. Lighter material gauges, alternate material types and finishes are not acceptable. All unexposed interior surfaces shall be constructed of a minimum 18-gauge corrosion resistant stainless steel including, but not limited to ducts, plenum, and brackets. The hood(s) shall include a filter housing constructed of the same material as the hood. The filters shall be stainless steel baffle type (non-stick coating optional), U.L. 1046 Classified, and in sufficient number and size to ensure optimum performance. The filter housing shall terminate in a pitched, full length grease trough which shall drain into a removable grease container. These filters shall have a grease removal efficiency of 28% at 8 microns (16% from 3-10 microns) and static pressure drop of 0.5-0.6 inWC. Vapor proof, U.L. Listed incandescent (LED optional) light fixtures shall be pre-wired to a junction box located at the top of the hood for field connection. Wiring shall conform to the requirements of the NFPA® 70. The canopy hood(s) shall be built in accordance with the NFPA® 96, IMC, UMC, and bear the NSF Seal of Approval. The hood manufacturer shall provide, on request, the necessary data that confirms compliance with the code authorities listed above.

- d. (Item No. 58) MARK H-58 SECTION 1 - XBEW-120.00-S - 60" Deep
- e. Left Utility Fire Cabinet.
- f. (Item No. 58.1) MARK H-58.1 SECTION 2 -, XBEW-120.00-S - 60" Deep
- g. Lights - LED
- h. Ceiling Enclosures - 12 in. High on Left, Front and Right ends. KEC TO VERIFY CEILING HEIGHT.
- i. Continuous Capture - UL listed connection to join multiple sections.
- j. Controls to be provided by Mechanical Contractor
- k. Fire System - Provide factory pre-piped for Ansul R-102 fire protection system located in an integral utility cabinet on the right end of the hood (Item No.58). System shall provide surface, duct and plenum protection for items of cooking equipment located beneath the hood in accordance with all applicable codes and provisions of NFPA 17A and 96. All system piping shall be concealed where possible with exposed portions of either chrome fittings or stainless-steel sleeving. System shall be wired with shunt trip breaker and electric/gas shut-off valve serving items of cooking equipment beneath the hood to provide power and fuel shut-off in the event of system actuation.
- l. Products manufactured by Captive Aire and Gaylord, modified to comply with specifications, are acceptable.
- m. Products manufactured by Gaylor & Halton, modified to comply with specifications, are acceptable.

2.8.2.53 59. FRYER

- a. Pitco Model No. SG14RS-1FD*C014

b. Fryer System with Filter System, High Power, gas, (1) 40-50 lb. oil capacity full tank, millivolt control, stainless steel tank, front & sides, under-fryer drawer filtration, 10" adjustable legs, NSF, CE, CSA Flame, CSA Star, AuGA.

c. Provide unit with the following:

- 1) Natural gas.
- 2) Millivolt Thermostat
- 3) P6072145 Basket, (2) oblong/twin size, 13-1/2" x 6-1/2" x 5-3/4" deep, long handle, regular mesh per fryer.
- 4) B2101515 Tank Cover
- 5) B3902303 Casters, 10", rigid, locking.

d. Utilities are furnished through Item No. 57, Utility Distribution System.

e. Products manufactured by Vulcan & Frymaster, modified to comply with specifications, are acceptable.

2.8.2.54 61. CONVECTION STEAMER

a. Cleveland Model No. 24CGA10.2ES*C014

b. Convection Steamer, pressureless, gas, 2 compartments with individual generators, (5) 12 x 20 x 2-1/2 pans/compartment capacity, SureCook controls, 60-minute mechanical timer & manual (continuous steaming) bypass switch, left-hand hinged door, controls on right, 1 standard treated & tap water connection, stainless steel construction, 6" adjustable legs with flanged feet.

c. Provide unit with the following:

- 1) Natural Gas
- 2) Performance Start Up
- 3) INSKITCGA6 Installation Kit.

d. Utilities are furnished through Item No. 57, Utility Distribution System.

e. Products manufactured by Vulcan & Market Forge, modified to comply with specifications, are acceptable.

2.8.2.55 62. COMBI OVEN

a. Alto-Shaam Model No. CTP6-10E*C014

b. Combi Oven/Steamer, electric, boilerless, countertop, capacity (7) 18" x 13" half size sheet or (7) 12" x 20" full size hotel (1/1 GN) pan capacity, PROtouch control with steam/convection/combi/retherm modes, removable single-point temperature probe, (2) power levels, (4) cooking modes, programmable cool-down, SafeVent™ steam venting,

CombiClean PLUS™ with (5) cleaning levels, CoolTouch3™ glass window, door hinged right, high efficiency LED lighting, (2) side racks with (7) non-tilt support rails, stainless steel construction, adjustable stainless steel legs, EcoSmart®, cULus, UL EPH Classified, CE, IPX5, EAC.

c. Provide unit with the following:

- 1) ECO power
- 2) (2) Removable single-point temperature probe
- 3) 5016711 Stacking Hardware
- 4) 5017404 Mobile Stacking Base

d. Utilities are furnished through Item No. 57, Utility Distribution System.

e. Products manufactured by AltoShaam & Blodgett, modified to comply with specifications, are acceptable.

2.8.2.56 63. SPACER TABLE

a. Advance Tabco Model No. TFMS-153*C014

b. Filler Table, 15"W x 36"D, 16 gauge 304 stainless steel top with 1-1/2"H rear up-turn, stainless steel legs & adjustable bullet feet, NSF.

c. Products manufactured by Eagle & John Boos, modified to comply with specifications, are acceptable.

2.8.2.57 64. CONVECTION OVEN

a. Southbend Model No. BGS/22SC*C014

b. Convection Oven, gas, double-deck, standard depth, (5) plated racks, 11- position rack glides, porcelain interior, (2) stainless steel dependent doors with windows, solid state controls, electronic ignition, 60-minute cook timer, 2-speed fan, oven interior light, stainless steel front, top, sides & door, porcelain interior, 6" painted steel triangular legs, (2) NEMA 5-15P, (2) 1/2 HP, CSA, NSF.

c. Provide unit with the following:

- 1) Natural Gas.
- 2) 6" Casters
- 3) Downdraft Flue Diverter

d. Utilities are furnished through Item No. 57, Utility Distribution System.

e. Products manufactured by Vulcan & Blodgett, modified to comply with specifications, are acceptable.

2.8.2.58 65. PREP TABLE W/ SINK

- a. Atlanta Custom Fabricator
- b. Provide fabricated, stainless steel Prep Table w/ Sink, size and shape as shown on Drawings. Provide one drawer and undershelf.
- c. Where shown on Drawings, cut out top to accommodate a one compartment sink. Sink compartment to be 20"x20"x12" deep. Provide lever waste for each sink compartment as described under "Fabricated Metal Equipment". Paint exposed copper drain lines silver to match stainless steel table.
- d. Where adjacent to wall provide with a typical 8 inch high backsplash with 2 inch turnback on 45 degree angle with enclosed welded ends. Front and sides to have marine edge. Refer to Drawing for typical tabletop construction details.
- e. (Item No. 65.1) T&S Brass B-0231-CR-KIT Pantry Faucet, double, wall mount, 8" centers, 12" swing nozzle, lever handles, stream regulator tip, quarter-turn Cerama cartridge, low lead, (2) 24" flex hose, 1/2" NPT, NSF, ADA Compliant
- f. T&S Brass B-0199-01 Aerator, non-splash, 55/64" -27 female aerator threads, fits goosenecks & nozzles
- g. Reference the listing of approved fabricators in Section 2.3; Fabricated Metal Equipment of this specification.

2.8.2.59 66. WALL SHELF

- a. Atlanta Custom Fabricator
- b. Provide fabricated 16-gauge, stainless steel Wall Shelf. Wall Shelf to be size and shape as shown on drawings.
- c. Refer to Elevation Drawings for mounting height.
- d. Shelf sides and rear to flange up 2". Front to have 1-1/2" rolled down edge. Support Shelf on wall by heavy gauge stainless steel brackets or by approved alternate means.
- e. Reference the listing of approved fabricators in Section 2.3; Fabricated Metal Equipment of this specification.

2.8.2.60 67. PASS-THRU HEATED CABINET

- a. Continental Model No. DL1WE-SS-GD-PT-MOD*C014
- b. Heated Cabinet, extra wide pass-thru, one-section, 22 cu. ft. capacity, (3) shelves, stainless steel exterior & interior, standard depth, hinged doors, electronic control with digital display, hi-low alarm, CETLus, NSF.
- c. Provide unit with the following:
 - 1) Doors hinged as per plan

- 2) Controls & glass doors to kitchen side
- 3) 5" Casters
- 4) 50-P008A-E Universal Pan Slide Assembly, full section universal slides for 18 x 26 or (2) 12 x 20 pans on 5" centers, bottom support, stainless steel angles.

d. Products manufactured by True & Delfield, modified to comply with specifications, are acceptable.

2.8.2.61 68. PASS-THRU REFRIGERATOR

a. Continental Model No. D1RENSSGDPT-MOD*C014

b. Refrigerator, pass thru, 28-1/2"W, one-section, self-contained refrigeration, stainless steel exterior & interior, stainless steel front, standard depth cabinet, wide full-height glass door, cylinder lock, electronic control with digital display, hi-low alarm, unit comes standard with expansion valve, 6" stainless steel legs, R290 hydrocarbon refrigerant, 1/4 HP, cETLus, NSF.

c. Provide unit with the following:

- 1) Doors hinged as per plan
- 2) Controls & glass door to kitchen side
- 3) 5" Casters
- 4) 50-P008A-E Universal Pan Slide Assembly, full section universal slides for 18 x 26 or (2) 12 x 20 pans on 5" centers, bottom support, stainless steel angles.

d. Products manufactured by True & Delfield, modified to comply with specifications, are acceptable.

2.8.2.62 69. MOBILE HEATED CABINET

a. Cres Cor Model No. H339214C*C014

b. Cabinet, Mobile Heated, stacked, insulated, channel pan slides, capacity (16) 18" x 26" or (16) 12" x 20" pans, slides on 2-3/4" centers, anti-microbial latches, analog thermometer, stainless steel construction, (4) heavy duty 5" swivel casters (2) braked, cCSAus, CSA.

c. Provide unit with the following:

- 1) Lexan Doors

d. Products manufactured by Metro & Winston, modified to comply with specifications, are acceptable.

2.8.2.63 71. WALL SHELF

a. Atlanta Custom Fabricator

b. Provide fabricated 16-gauge, stainless steel Wall Shelf. Wall

Shelf to be size and shape as shown on drawings.

- c. Refer to Elevation Drawings for mounting height.
- d. Shelf sides and rear to flange up 2". Front to have 1-1/2" rolled down edge. Support Shelf on wall by heavy gauge stainless steel brackets or by approved alternate means.
- e. Reference the listing of approved fabricators in Section 2.3; Fabricated Metal Equipment of this specification.

2.8.2.64 72. WORKTABLE

- a. Atlanta Custom Fabricator
- b. Provide fabricated, stainless steel Worktable, size and shape as shown on Drawings. Provide one drawer and undershelf.
- c. Where adjacent to wall provide with a typical 4 inch high backsplash with 1 inch turnback on 45 degree angle with enclosed welded ends. Front and sides to have rolled edge. Refer to Drawing for typical tabletop construction details.
- d. Reference the listing of approved fabricators in Section 2.3; Fabricated Metal Equipment of this specification.

2.8.2.65 73. STORAGE SHELVING

- a. Metro Model No. NK4 SERIES*C014
- b. Provide shelving units comprised of the following:
 - 1) Metro Model No. 2160NK4
 - 2) 74UPK4 Post, Utilities are furnished through Item No. 57, Utility Distribution System.
 - 3) 5PC Stem Caster, swivel, 5" dia., 1-1/4" face, 300 lb. capacity, corrosion resistant, polyurethane flat wheel tread, polymer horn, includes bumper.
 - 4) 5PCB Stem Caster, swivel (with foot operated brake), 5" dia., 1-1/4" face, 300 lb. capacity, corrosion resistant, polyurethane flat wheel tread, polymer horn, includes bumper.
- c. Verify dimensions in field and coordinate with shelving unit to ensure a proper fit. Provide shelving with standard finish and accessories necessary for a complete installation.
- d. Products manufactured by Eagle & Quantum, modified to comply with specifications, are acceptable.

2.8.2.66 74. PASS-THRU HEATED CABINET

- a. Continental Model No. DL1WE-SS-GD-PT-MOD*C014
- b. Heated Cabinet, extra wide pass-thru, one-section, 22 cu. ft. capacity, (3) shelves, stainless steel exterior & interior, standard depth, hinged doors, electronic control with digital display, hi-low

alarm, cETLus, NSF.

c. Provide unit with the following:

- 1) Doors hinged as per plan
- 2) Controls & glass door to kitchen side
- 3) 5" Casters
- 4) 50-P008A-E Universal Pan Slide Assembly, full section universal slides for 18 x 26 or (2) 12 x 20 pans on 5" centers, bottom support, stainless steel angles.

d. Products manufactured by True & Delfield, modified to comply with specifications, are acceptable.

2.8.2.67 75. PASS-THRU REFRIGERATOR

a. Continental Model No. D1RENSSGDPT-MOD*C014

b. Refrigerator, pass thru, 28-1/2"W, one-section, self-contained refrigeration, stainless steel exterior & interior, stainless steel front, standard depth cabinet, wide full-height glass door, cylinder lock, electronic control with digital display, hi-low alarm, unit comes standard with expansion valve, 6" stainless steel legs, R290 hydrocarbon refrigerant, 1/4 HP, cETLus, NSF.

c. Provide unit with the following:

- 1) Doors hinged as per plan
- 2) Controls & glass door to kitchen side
- 3) 5" Casters
- 4) 50-P008A-E Universal Pan Slide Assembly, full section universal slides for 18 x 26 or (2) 12 x 20 pans on 5" centers, bottom support, stainless steel angles.

d. Products manufactured by True & Delfield, modified to comply with specifications, are acceptable.

2.8.2.68 76. PREP TABLE W/ SINK

a. Atlanta Custom Fabricator

b. Provide fabricated, stainless steel Prep Table w/ Sink, size and shape as shown on Drawings. Provide one drawer and undershelf.

c. Where shown on Drawings, cut out top to accommodate a one compartment sink. Sink compartment to be 20"x20"x12" deep. Provide lever waste for each sink compartment as described under "Fabricated Metal Equipment". Paint exposed copper drain lines silver to match stainless steel table.

d. Where adjacent to wall provide with a typical 8 inch high backsplash with 2 inch turnback on 45 degree angle with enclosed welded ends. Front and sides to have marine edge. Refer to Drawing for

typical tabletop construction details.

e. (Item No. 76.1) T&S Brass B-0231-CR-KIT Pantry Faucet, double, wall mount, 8" centers, 12" swing nozzle, lever handles, stream regulator tip, quarter-turn Cerama cartridge, low lead, (2) 24" flex hose, 1/2" NPT, NSF, ADA Compliant

f. T&S Brass B-0199-01 Aerator, non-splash, 55/64"-27 female aerator threads, fits goosenecks & nozzles

g. Reference the listing of approved fabricators in Section 2.3; Fabricated Metal Equipment of this specification.

2.8.2.69 77. WALL SHELF

a. Atlanta Custom Fabricator

b. Provide fabricated 16-gauge, stainless steel Wall Shelf. Wall Shelf to be size and shape as shown on drawings.

c. Refer to Elevation Drawings for mounting height.

d. Shelf sides and rear to flange up 2". Front to have 1-1/2" rolled down edge. Support Shelf on wall by heavy gauge stainless steel brackets or by approved alternate means.

e. Reference the listing of approved fabricators in Section 2.3; Fabrication of this specification.

2.8.2.70 79. SINK HEATER

a. Hatco Model No. 3CS-9B*C014

b. Sink Heater, Electric, undersink design, electric operation, stainless steel front, for over 21" square sink area, 9.0 kW (balanced), NSF, CE, cULus.

c. Provide unit with the following:

1) 480v/50/60/3-ph.

d. Products manufactured by Hubble, modified to comply with specifications, are acceptable.

2.8.2.71 80. POWER WASH SINK

a. Bi-Line Conveyor Systems Model No. VWS*C014

b. Type 304, 14-gauge, polished stainless-steel construction.

c. 9.5" high x 2-1/2" deep back splash.

d. 21" Deep wash tank, w/twist lever drain.

e. 18" Deep rinse/sanitizer sinks, w/twist lever drains.

f. 1-1/2" Rolled edge front.

g. Hemmed edge both ends.

- h. Stainless steel legs and cross rails fully welded.
- i. Stainless steel adjustable bullet feet.
- j. Rear discharge w/removable suction screen
- k. 3 HP TFEC wash pump motor with permanently sealed bearings.
- l. SST impeller, & motor overload protection, w/manual reset.
- m. Low water protection for wash pump motor.
- n. 5,000-watt wash tank heater.
- o. SST Front fascia panel.
- p. Provide unit with the following:
 - 1) Overall length 175".
 - 2) Direction to be Right to Left.
 - 3) Voltage: 480V-3PH, 10.0 AMPS
 - 4) 28" soiled drain board with hemmed end.
 - 5) 20" scrap sink with removable basket.
 - 6) 13" transition drainboard to house control panel
 - 7) 36" power wash sink with maintenance heater.
 - 8) 24" rinse sink.
 - 9) 24" sanitizer sink.
 - 10) 28" clean drain board with hemmed end.
 - 11) (2) 3/4" mixing faucets - Bi-Line (Item 80.1)
 - 12) Pre-Rinse - Bi-Line (Item 80.1)
 - 13) Sheet pan rack.
 - 14) Utensil basket.
 - 15) Provisions for mounting sink heater
- q. Products manufactured by Hobart & PowerSoak modified to comply with specifications, are acceptable.

2.8.2.72 81. POT RACK

- a. Advance Tabco Model No. SW-108*C014
- b. Pot Rack, wall-mounted, double bar design, 108"W x 12"D, constructed of 1/4" x 2" stainless steel, includes: (18) plated double pot hooks, NSF.

- c. Products manufactured by Eagle & John Boos, modified to comply with specifications, are acceptable.

2.8.2.73 82. DRYING RACK

- a. Metro Model No. MAX4-PR48VX4*C014
- b. Provide shelving units comprised of the following:
 - 1) Mobile Drying Rack Unit, 48"W x 24"D x 68"H, 4-tier, includes: (4) open shelf frames, (4) 63" mobile posts, (2) cutting board/tray drying racks, (2) pan racks, (4) polymer swivel casters (2 with brakes), built in Microban® antimicrobial product protection, NSF.
- c. Verify dimensions in field and coordinate with shelving unit to ensure a proper fit. Provide shelving with standard finish and accessories necessary for a complete installation.
- d. Products manufactured by Eagle & Quantum, modified to comply with specifications, are acceptable.

2.8.2.74 83. MATTOP CONVEYOR

- a. Bi-Line Conveyor Systems Model No. MT12*C014
- b. Bi-line Systems Custom soiled tray conveyor, complete with:
 - 1) All stainless-steel table construction (14 gauge 304)
 - 2) Single 12" interlocking belt
 - 3) Electrical control panel 208V/1PH
 - 4) Drive cabinet w/ belt wash
 - 5) Sloped drip pan with flushing system for belt return
 - 6) Recessed sump(s) with chute below belt for cleanability
 - 7) Variable speed drive
 - 8) UHMW guides and drip pan for belt return
 - 9) 1-5/8" diameter tubular legs and cross tubes
 - 10) Adjustable bullet feet
 - 11) SST sight and sound barrier with (2) recessed LED light fixtures.
- c. Soiled Tabling
 - 1) Scrap sink w/rack guide to accommodate (Item No. 84) Disposer by Others.
 - 2) Integral part of trough tabling and MT12 conveyor
 - 3) Double overhead rack shelf length of trough

- 4) Deck/splash mount pre-rinse sprayer
- 5) Wash down hose station.
- 6) (2) Trough bridges.
- 7) Trough magnet.
- 8) Trough gusher.
- 9) Limit switch.
- 10) 1-5/8" Diameter tubular legs and cross tubes.
- 11) Adjustable bullet feet

d. Products manufactured by Hobart, modified to comply with specifications, are acceptable.

2.8.2.75 84. DISPOSER

- a. Salvajor Model No. 500-SA-6-WSP*C014
- b. Disposer, Sink Assembly, 6-1/2" sink collar, 5 Hp motor, start/stop push button, drain/flush/time delay, automatic reversing & water saving with safety line disconnect ARSS-LD control, includes fixed nozzle, chrome plated vacuum breaker, solenoid valve, sink stopper & flow control, heat treated aluminum alloy housing, single support leg, UL, CSA, CE.
 - 1) 460v/60/3-ph, 6.3 amps.
 - 2) DP Stainless steel dejamming prong
 - 3) Omit vacuum breaker and provide B0455-04, manufactured by T & S Brass and Bronze Works.
- c. Products manufactured by Hobart & InsinkErator, modified to comply with specifications, are acceptable.

2.8.2.76 85. CONVEYOR DISH MACHINE

- a. Champion Model No. 66 PRO*C014
- b. Conveyor Dishwasher, 66"W, (44" single tank + 22" prewash), Proportional Rinse, Progressive anti-jam drive system, top mounted Prodigy series HMI user interface, Proactive maintenance software, 100 gallons per hour with energy sentinel (idle pump shut-off), (209) racks per hour, single-piece hood design, single-piece stainless steel upper & lower wash arms manifolds, internal removable scrap basket, dual-piece scrap screens, 20" standard vertical clearance which accommodate 18" x 26" sheet pans, full 180° opening leak proof insulated hinged access doors, automatic tank fill, door safety switches, leak-proof ball valve drains, lower front & side enclosure panels, stainless steel heavy gauge construction including base & legs, electric tank heat, 2 HP prewash and wash pumps, single point machine & booster connection, vent fan control, stainless steel rear manifolds, NSF, cULus.

- c. Provide unit with the following:
 - 1) Complimentary factory authorized performance test included, upon equipment start-up. Consult local Champion sales representative for coordination of the start-up.
 - 2) Left-to-right operation.
 - 3) Champion ION scale prevention system (un-mounted).
 - 4) 480v/60/3-ph.
 - 5) Single point electrical connection.
 - 6) Electric tank heat.
 - 7) Electric booster, 70° rise, 21kW, built in.
 - 8) Detergent & Rinse-aid pumps (mounted & inter-wired).
 - 9) Drain water tempering kit (un-mounted).
 - 10) Stainless steel vent cowl with 7" stack & locking damper.
 - 11) 20" High hood vertical clearance.
 - 12) Table limit switch, whisker style (unmounted).
 - 13) 101273 Flat Bottom Dishrack, 20" x 20", additional.
 - 14) 101285 Peg Dishrack, 20" x 20", additional.
 - 15) 117268 Sheet pan rack.
- d. Products manufactured by Hobart modified to comply with specifications, are acceptable.

2.8.2.77 86. VENT DUCT RISER

- a. Atlanta Custom Fabricator
- b. Provide fabricated exhaust Duct Riser, size and shape as shown on Drawings.
- c. (Item No. 86.1) Provide a fabricated, 16-gauge stainless steel sleeve. Attach sleeve to duct at ceiling penetrations.
- d. Reference the listing of approved fabricators in Section 2.3; Fabricated Metal Equipment of this specification.

2.8.2.78 87. CLEAN GRAVITY ROLLER

- a. Bi-Line Conveyor Systems Model No. GRC21*C014
- b. Provide unit with the following:
 - 1) Clean Gravity Roller Table.

- 2) 90° configuration per supplied drawing.
 - 3) 1.9" PVC gravity rollers on removable racks.
 - 4) SST Flat heat/chemical tolerant shelf at lead end of clean table.
 - 5) 1-5/8" diameter tubular legs and cross tubes with adjustable bullet feet.
 - 6) Accumulation switch provided with Champion dish machine.
- c. Products manufactured by Hobart, modified to comply with specifications, are acceptable.

2.8.2.79 88. POT STORAGE SHELVE

- a. Metro Model No. NK4 SERIES*C014
- b. Provide shelving units comprised of the following:
- 1) Metro Model No. 2460NK4
 - 2) 74UPK4 Post, 73-7/8"H, for use with stem casters, Metroseal Gray epoxy coated corrosion-resistant finish with Microban® antimicrobial protection.
 - 3) 5PC Stem Caster, swivel, 5" dia., 1-1/4" face, 300 lb. capacity, corrosion resistant, polyurethane flat wheel tread, polymer horn, includes bumper.
 - 4) 5PCB Stem Caster, swivel (with foot operated brake), 5" dia., 1-1/4" face, 300 lb. capacity, corrosion resistant, polyurethane flat wheel tread, polymer horn, includes bumper.
- c. Verify dimensions in field and coordinate with shelving unit to ensure a proper fit. Provide shelving with standard finish and accessories necessary for a complete installation.
- d. Products manufactured by Eagle & Quantum, modified to comply with specifications, are acceptable.

2.8.2.80 91. EXHAUST HOOD W/FIRE SYSTEM

- a. Accurex Model No. XBEW-120-S*C014
- b. (Item No. 91.1) Accurex Model No. XBEW-120-S*C014
- c. Accurex Exhaust Hood Model XBEW as shown on plans and in accordance with the following specification:
- d. Type I, exhaust only wall low proximity canopy suitable for all types of cooking applications. The hood(s) shall be U.L. 710 Listed without a fire damper (with optional) for medium, heavy, or extra-heavy duty rated cooking appliances. Make-up air shall be independently provided. The hood(s) exterior shall be constructed of a minimum of 18 gauge 300 series stainless steel. The hood(s) shall be constructed using the standing seam method for optimum strength and with a Performance Enhancing Lip (PEL) to improve capture efficiency by turning air back into the hood. Front panels shall be of double wall construction with

1-inch insulation to add additional strength and rigidity. An integral 3-inch air space is provided to meet NFPA® 96 clearance requirements against limited combustibles walls. Integral 3-inch air space may be omitted for non-combustible construction. All seams, joints and penetrations of the hood enclosure shall be welded and/or liquid tight. Lighter material gauges, alternate material types and finishes are not acceptable. All unexposed interior surfaces shall be constructed of a minimum 18-gauge corrosion resistant stainless steel including, but not limited to ducts, plenum, and brackets. The hood(s) shall include a filter housing constructed of the same material as the hood. The filters shall be stainless steel baffle type (non-stick coating optional), U.L. 1046 Classified, and in sufficient number and size to ensure optimum performance. The filter housing shall terminate in a pitched, full length grease trough which shall drain into a removable grease container. These filters shall have a grease removal efficiency of 28% at 8 microns (16% from 3-10 microns) and static pressure drop of 0.5-0.6 inWC. Vapor proof, U.L. Listed incandescent (LED optional) light fixtures shall be pre-wired to a junction box located at the top of the hood for field connection. Wiring shall conform to the requirements of the NFPA® 70. The canopy hood(s) shall be built in accordance with the NFPA® 96, IMC, UMC, and bear the NSF Seal of Approval. The hood manufacturer shall provide, on request, the necessary data that confirms compliance with the code authorities listed above.

- e. Lights - LED
- f. Backsplash - 114 in High 120 in Long 0 in Wide, Right End Splash 114 in High 14 in Long 0 in Wide, Left End Splash 114 in High 14 in Long 0 in Wide.
- g. Ceiling Enclosures - 12 in. High on Left, Front and Right ends. KEC TO VERIFY CEILING HEIGHT.
- h. Continuous Capture - UL listed connection to join multiple sections.
- i. Controls to be provided by Mechanical Contractor
- j. Fire System - Provide factory pre-piped for Ansul R-102 fire protection system located in an integral utility cabinet on the right end of the hood (Item No.91 & 91.1). System shall provide surface, duct and plenum protection for items of cooking equipment located beneath the hood in accordance with all applicable codes and provisions of NFPA 17A and 96. All system piping shall be concealed where possible with exposed portions of either chrome fittings or stainless-steel sleeving. System shall be wired with shunt trip breaker and electric/gas shut-off valve serving items of cooking equipment beneath the hood to provide power and fuel shut-off in the event of system actuation.
- k. Products manufactured by Captive Aire and Gaylord, modified to comply with specifications, are acceptable.
- l. Products manufactured by Gaylor & Halton, modified to comply with specifications, are acceptable.

2.8.2.81 92. WORKTOP FREEZER

- a. Continental Model No. SWF27NBS*C014

- b. Work Top Freezer, 27"W, 7.4 cu ft capacity, one-section, stainless steel top with 5-1/2"H backsplash, (1) field rehingeable door, stainless steel front & end panels, aluminum interior, rear mounted self-contained refrigeration, R290 Hydrocarbon refrigerant, 1/4 HP, cETLus, NSF.
- c. Provide unit with the following:
 - 1) Door hinged on left.
 - 2) Casters, 5".
 - 3) (Item No. 92.1) Worktop Freezer, Continental Refrigerator Model No. SWF27NBS, Work Top Freezer, 27"W, 7.4 cu ft capacity, one-section, stainless steel top with 5-1/2"H backsplash, (1) field rehinge able door, stainless steel front & end panels, aluminum interior, rear mounted self-contained refrigeration, R290 Hydrocarbon refrigerant, 1/4 HP, cETLus, NSF.
 - (a) Door hinged on right.
 - (b) Casters, 5".
- d. Products manufactured by True & Delfield, modified to comply with specifications, are acceptable.

2.8.2.82 93. FRYER BATTERY

- a. Pitco Model No. SG14RS-1FD*C014
- b. Fryer System with Filter System, High Power, gas, (1) 40-50 lb. oil capacity full tank, millivolt control, stainless steel tank, front & sides, under-fryer drawer filtration, 10" adjustable legs, NSF, CE, CSA Flame, CSA Star, AuGA.
- c. Provide unit with the following:
 - 1) Natural gas.
 - 2) Millivolt Thermostat
 - 3) P6072145 Basket, (2) oblong/twin size, 13-1/2" x 6-1/2" x 5-3/4" deep, long handle, regular mesh per fryer.
 - 4) B2101515 Tank Cover
 - 5) B3902303 Casters, 10", rigid, locking.
- d. T&S Brass Model No. HG-4D-48SK, Safe-T-Link Gas Connector Kit, 3/4" connection, 48" hose, stainless steel braiding with extruded coating, (2) Swivelink fittings, (1) 90° elbow, ball valve, necessary hardware, with Surelink restraining cable adjustable for 3' to 5', 215,000 BTU/hr minium flow capacity.
- e. Products manufactured by Vulcan & Frymaster, modified to comply with specifications, are acceptable.

2.8.2.83 94. FRYER DUMP STATION

- a. Pitco Model No. BNB-SG14*C014
- b. Bread & Batter Cabinet, with BNB dump station, fryer match design, approximately 15-5/8" wide, includes 4-5/8" recessed pan and screen, standard finish, stainless steel front, sides & door, NSF.
- c. Provide unit with the following:
 - 1) PFW-1 Food Warmer, built-in, 750watt, CSA, NSF, UL.
 - 2) B3901504 Casters, 9" adjustable swivel (set of 4) non-lock rear & lock front casters.
- d. Products manufactured by Vulcan & Frymaster, modified to comply with specifications, are acceptable.

2.8.2.84 95. REFRIGERATED CHEF BASE

- a. Continental Model No. D36GN*C014
- b. Refrigerator Griddle Stand, one-section, (2) drawers - accommodates (1) 12" x 20" x 6" & (1) 6" x 20" x 6", stainless steel top with drip guard marine edge, stainless steel exterior & interior, electronic control with digital display, hi-low alarm, high/low temperature alarm, self-contained refrigeration, R290 hydrocarbon refrigerant, 1/5 HP, 10' cord, cETLus, NSF.
- c. Products manufactured by True & Delfield, modified to comply with specifications, are acceptable.

2.8.2.85 96. GRIDDLE

- a. Vulcan Model No. MSA36-C0100P*C014
- b. Heavy Duty Griddle, countertop, gas, 36" W x 24" D cooking surface, 18mm (3/4") griddle plate embedded mechanical snap action thermostat every 12", millivolt pilot safety, piezo ignition, low profile, stainless steel front, sides, front grease trough, 4" back & tapered side splashes, 4" adjustable legs, CSA Star, CSA Flame, NSF.
- c. Provide unit with the following:
 - 1) Natural gas.
- d. T&S Brass Model No. HG-4D-48SK, Safe-T-Link Gas Connector Kit, 3/4" connection, 48" hose, stainless steel braiding with extruded coating, (2) Swivelink fittings, (1) 90° elbow, ball valve, necessary hardware, with Surelink restraining cable adjustable for 3' to 5', 215,000 BTU/hr minium flow capacity.
- e. Products manufactured by Star & Garland, modified to comply with specifications, are acceptable.

2.8.2.86 97. COOK PREP UNIT

- a. Continental Model No. D27N8-FB-D*C014

- b. Sandwich Unit, Front Breather, 27"W, one-section, (8) 1/6 size x 4" deep pans with 12" cutting board, (2) drawers, accommodates (1) 12 x 20 x 6 pan per drawer (supplied by others), stainless steel top, front, sides & interior, electronic control with digital display, hi-low alarm, 3-3/4" casters, rear mounted self-contained refrigeration, automatic hot gas condensate evaporator, R290 hydrocarbon refrigerant, 1/5 hp, cETLus, NSF.
- c. Products manufactured by True & Delfield, modified to comply with specifications, are acceptable.

2.8.2.87 98. BREATH GUARD

- a. BSI Model No. ZQ500*C014
- b. Vertical Food Shield, single, full service, fully adjustable, 20-1/2" height, 24 1/2" wide tempered glass front glass, 1" diameter tubing single supports, cULus.
- c. Provide the unit with the following:
 - 1) Food Shield Length & Segments per plans
 - 2) Brushed stainless finish
- d. Mounting style as selected by Architect/Interiors.
- e. Products manufactured by Versa-Gard & English Mfg., modified to comply with specifications, are acceptable.

2.8.2.88 100. WORK COUNTER W/SINK

- a. Atlanta Custom Fabricator
- b. Provide fabricated stainless steel cabinet base Work Counter W/Sink. Provide with hinged doors, intermediate shelf and bottom shelf, size and shape as shown on Drawings. See section detail 2/QF701
- c. Where adjacent to wall provide with a typical 8 inch high backsplash with 2 inch turnback on 45 degree angle with enclosed welded ends. Front and sides to have marine edge. Refer to Drawing for typical tabletop construction details.
- d. Provide cutout in cabinet base for undercounter equipment.
- e. Where shown on Drawings, provide a one compartment dump sink, 14"x 16"x 12" deep sink compartment.
- f. (Item No. 100.1) T&S Brass B-0325-CC-CR Mixing Faucet, deck mount, 4" adjustable centers, 5-3/4" swivel gooseneck spout with Series 1 stream regulator outlet (includes lock washer to convert to rigid), lever handles with color coded indexes, quarter-turn Cerama cartridges with check valves, polished chrome plated brass body, 1/2" NPT male inlets, low lead, cCSAus, ADA Compliant .
- g. T&S Brass B-0199-01 Aerator, non-splash, 55/64" -27 female aerator threads, fits goosenecks & nozzles
- h. Reference the listing of approved fabricators in Section 2.3;

Fabricated Metal Equipment of this specification.

2.8.2.89 101. WALL SHELF

- a. Atlanta Custom Fabricator
- b. Provide fabricated 16-gauge, stainless steel Wall Shelf. Wall Shelf to be size and shape as shown on drawings.
- c. Refer to Elevation Drawings for mounting height.
- d. Shelf sides and rear to flange up 2". Front to have 1-1/2" rolled down edge. Support Shelf on wall by heavy gauge stainless steel brackets or by approved alternate means.
- e. Reference the listing of approved fabricators in Section 2.3; Fabricated Metal Equipment of this specification.

2.8.2.90 102. PIZZA / SANDWICH OVEN

- a. TurboChef Model No. HHD-9500*C014
- b. Double Oven, electric, ventless, countertop, stackable, (2) independent decks, store up to 800 recipes (400 per cavity), smart voltage sensor technology (North America only), internal catalytic converters, 16" pizza capacity per deck, (1) oven cleaner, (1) oven guard, (1) aluminum paddle, (2) trigger sprayers, (2) standard racks, (2) top & bottom jetplates, stainless steel front, top & sides, rubber seal for surface mounting, cULus, UL EPH Classified, TÜV, CE.
- c. Provide unit with the following:
 - 1) CON-7006 ChefComm Pro, Full Access, with USB Smart Card Reader.

2.8.2.91 103. CUTTING BOARD

- a. By Owner

2.8.2.92 104. UNDERCOUNTER REFRIGERATOR

- a. Continental Model No. D48N-U*C014
- b. Undercounter Refrigerator, 48"W, two-section, (2) field rehingeable doors, stainless steel exterior & interior, stainless steel top, 1-3/8" diameter plate casters, front breathing, electronic control with digital display, hi-low alarm, rear mounted self-contained refrigeration, R290 hydrocarbon refrigerant, 1/5 hp, cETLus.
- c. Products manufactured by True & Delfield modified to comply with specifications, are acceptable.

2.8.2.93 105. WORK COUNTER W/SINK

- a. Atlanta Custom Fabricator
- b. Provide fabricated stainless steel cabinet base Work Counter W/Sink. Provide with hinged doors, intermediate shelf and bottom shelf, size

and shape as shown on Drawings. See section detail 2/QF701.

- c. Where adjacent to wall provide with a typical 8 inch high backsplash with 2 inch turnback on 45 degree angle with enclosed welded ends. Front and sides to have marine edge. Refer to Drawing for typical tabletop construction details.
- d. Provide cutout in cabinet base for undercounter equipment.
- e. Where shown on Drawings, provide a one compartment sink. Dump sink to 14"x 16"x 12" deep sink compartment.
- f. (Item No. 105.1) T&S Brass B-0325-CC-CR Mixing Faucet, deck mount, 4" adjustable centers, 5-3/4" swivel gooseneck spout with Series 1 stream regulator outlet (includes lock washer to convert to rigid), lever handles with color coded indexes, quarter-turn Cerama cartridges with check valves, polished chrome plated brass body, 1/2" NPT male inlets, low lead, cCSAus,ADA Compliant
- g. T&S Brass B-0199-01 Aerator, non-splash, 55/64" -27 female aerator threads, fits goosenecks & nozzles
- h. Reference the listing of approved fabricators in Section 2.3; Fabricated Metal Equipment of this specification.

2.8.2.94 106. TEA BREWER

- a. By Product Supplier

2.8.2.95 107. COFFEE BREWER

- a. By Product Supplier

2.8.2.96 108. WALL SHELF

- a. Atlanta Custom Fabricator
- b. Provide fabricated 16-gauge, stainless steel Wall Shelf. Wall Shelf to be size and shape as shown on drawings.
- c. Refer to Elevation Drawings for mounting height.
- d. Shelf sides and rear to flange up 2". Front to have 1-1/2" rolled down edge. Support Shelf on wall by heavy gauge stainless steel brackets or by approved alternate means.
- e. Reference the listing of approved fabricators in Section 2.3; Fabricated Metal Equipment of this specification.

2.8.2.97 109. UNDERCOUNTER REFRIGERATOR

- a. Continental Model No. D48N-U*C014
- b. Undercounter Refrigerator, 48"W, two-section, (2) field rehingeable doors, stainless steel exterior & interior, stainless steel top, 1-3/8" diameter plate casters, front breathing, electronic control with digital display, hi-low alarm, rear mounted self-contained refrigeration, R290 hydrocarbon refrigerant, 1/5 hp, cETLus.
- c. Products manufactured by True & Delfield, modified to comply with

specifications, are acceptable.

2.8.2.98 112. SERVING COUNTER - SHORT ORDER LINE

- a. Atlanta Custom Fabricator
- b. Provide fabricated 16-gauge stainless steel base serving counter. Knee wall with finish to be provided by architect / interiors.
- c. Fabricated counter to be provided with quartz countertop as selected by Architect. Refer to architectural drawings and specifications for selection.
- d. Provide with 10" stainless steel apron to mount equipment controls. Provide cut-outs and openings for equipment, undershelves, and 1 5/8 diameter legs where shown on plans. Reference drawings for serving counter construction. See section detail 3/QF701.
- e. Working height shall be 34" unless detailed otherwise.
- f. Provide fabricated stainless steel Drip Trough, size and shape as shown on Drawings. Drip Trough shall be constructed of 14 gauge, stainless steel and be fully welded and press formed. Provide Drip Trough with drain located at the center. Drain to be 1 inch chrome plated. Bottom will incline towards drain at an angle to allow liquid flow toward drain. Provide Drip Trough with removable splash proof grates, maximum length of 24". Grate will be constructed of 14 gauge stainless steel and fabricated to fit inside Trough. Grate will set flush with top of Drip Trough.
- g. Provide 3" opening with grommet in countertop for counter top equipment.
- h. Reference the listing of approved fabricators in Section 2.3; Fabricated Metal Equipment of this specification.

2.8.2.99 113. PLATE DISPENSER

- a. Caddy Model No. CM-40*C014
- b. Dish Dispenser, drop in, open style, unheated, (1) self-leveling adjustable dispensing cylinder, approximate dish size 9-5/8" to 10-1/8" dia., stainless steel construction, NSF.
- c. Products manufactured by Eagle & Delfield, modified to comply with specifications, are acceptable.

2.8.2.100 114. BREATH GUARD

- a. BSI Model No. ZG9930*C014
- b. Food Shield, single, full service, fully adjustable, 20-1/2" height, 14" wide tempered glass top & 20" lower sneeze guard, 1" diameter tubing double supports, cULus.
- c. Provide unit with the following:
 - 1) Food Shield Length & Segments per plans

- 2) 705 Warmer & Light Combo
- d. Finish & mounting style as selected by Architect / Interiors.
- e. (Item No. 114.1) Breath Guard, BSI Model No. ZG9930, Food Shield, single, full service, fully adjustable, 20-1/2" height, 14" wide, tempered glass top & 20" lower sneeze guard, 1" diameter tubing double supports, cULus.
 - 1) Food Shield Length & Segments per plans
 - 2) 705 Warmer & Light Combo
- f. Finish & mounting style as selected by Architect / Interiors.
- g. Products manufactured by Versa-Gard & English Mfg., modified to comply with specifications, are acceptable.

2.8.2.101 115. DROP-IN HOT/COLD/FREEZE WELL

- a. Duke Model No. HCF-3*C014
- b. Hot/Cold/Freeze Drop-In Food Well Unit, heated & refrigerated, 49" long, (3) 12" x 20" individual pans, 300 series stainless steel top rim, 5" deep 300 series stainless steel interior liners, steel exterior housing, individual wired remote digital controls for hot or cold operation, air-cooled condensing unit, individual drains manifolded to a valve, 6' cord & plug, UL, cULus, NSF #4 & 7.
- c. Products manufactured by LTI modified to comply with specifications, are acceptable.

2.8.2.102 116. DROP-IN HOT/COLD/FREEZE WELL

- a. Duke Model No. HCF-2*C014
- b. Hot/Cold/Freeze Drop-In Food Well Unit, heated & refrigerated, 34" long, (2) 12" x 20" individual pans, 300 series stainless steel top rim, 5" deep 300 series stainless steel interior liners, steel exterior housing, individual wired remote digital controls for hot or cold operation, air-cooled condensing unit, individual drains manifolded to a valve, 6' cord & plug, UL, cULus, NSF #4 & 7.
- c. Products manufactured by LTI modified to comply with specifications, are acceptable.

2.8.2.103 117. REFRIGERATED SANDWICH PREP

- a. Continental Model No. D48N18M-D*C014
- b. Sandwich Unit, 48"W, two-section, (18) 1/6 size x 4" deep pans with 8" cutting board, (4) drawers, accommodates (1) 12 x 18 x 6 pan per drawer or (1) 1/2 x 6 pan & (1) 1/3 x 6 pans per drawer capacity, stainless steel top, front, sides & interior, electronic control with digital display, hi-low alarm, 6" adjustable legs, rear mounted self-contained refrigeration, automatic hot gas condensate evaporator, R290 hydrocarbon refrigerant, 1/4 hp, cETLus, NSF.
- c. Provide unit with the following:

- 1) 00FVL - Flat lid with vision panel and hinges.
- 2) 5" Casters

d. Products manufactured by True & Delfield, modified to comply with specifications, are acceptable.

2.8.2.104 118. BREATH GUARD

- a. BSI Model No. ZG9930*C014
- b. Food Shield, single, full service, fully adjustable, 20-1/2" height, 14" wide tempered glass top & 20" lower sneeze guard, 1" diameter tubing double supports, cULus.
- c. Provide unit with the following:
 - 1) Food Shield Length & Segments per plans
 - 2) 2580 LED Lighting
- d. Finish & mounting style as selected by Architect / Interiors.
- e. Products manufactured by Versa-Gard & English Mfg., modified to comply with specifications, are acceptable.

2.8.2.105 119. HEATED SHELF

- a. Hatco Model No. GRSBF-36-S*C014
- b. Heated Shelf with Flush Top, 37-1/2" x 25-1/2" surface area, hardcoat aluminum top, control thermostat, illuminated on/off switch & mounting bracket, 950 watts, NSF, CE, cUL, UL, UL EPH Classified, CSA.
- c. Provide unit with the following:
 - 1) Thermostat control with lighted rocker switch.
- d. Products manufactured by Duke & Vollrath, modified to comply with specifications, are acceptable.

2.8.2.106 120. BREATH GUARD

- a. BSI Model No. ZG9930*C014
- b. Food Shield, single, self service, fully adjustable, 20-1/2" height, 14" wide tempered glass top & lower sneeze guard, 1" diameter tubing double supports, cULus.
- c. Provide unit with the following:
 - 1) Food Shield Length & Segments per plans
 - 2) 705 Warmer & Light Combo.
- d. Finish & mounting style as selected by Architect / Interiors.
- e. Products manufactured by Versa-Gard & English Mfg., modified to comply with specifications, are acceptable.

2.8.2.107 121. DROP-IN REFRIGERATED MERCHANDISER

- a. Piper Products Model No. OTR-1*C014
- b. Food Display Case, drop-in, 32 1/3" L, self-serve, (3) intermediate glass shelves, recessed base, stainless steel top, rear glass doors & side panels, 30 1/4" above counter, 27 3/8" below counter, stainless steel frame, self- contained refrigeration, 1/2 HP.
- c. Provide unit with the following:
 - 1) Lockable Front roll down night cover.
 - 2) LED Lighted shelves.
 - 3) Glass Shelves, inclined, with stainless steel end stop.
- d. Products manufactured by Delfield modified to comply with specifications, are acceptable.

2.8.2.108 122. CUP DISPLAY

- a. By Owner

2.8.2.109 123. SODA DISPENSER

- a. By Product Supplier

2.8.2.110 124. TEA URN

- a. By Product Supplier

2.8.2.111 125. COFFEE WARMER W/THERMAL SAVER

- a. By Product Supplier

2.8.2.112 126. CUP DISPLAY

- a. By Owner

2.8.2.113 127. POINT OF SALE

- a. By Owner

2.8.2.114 128. WORK COUNTER W/DRIP TROUGH

- a. Atlanta Custom Fabricator
- b. Provide fabricated stainless steel Work Counter W/Drip Trough, provide with hinged doors, intermediate shelf and bottom shelf, size and shape as shown on Drawings. See section detail 1/QF701.
- c. Where adjacent to wall provide with a typical 4 inch high backsplash with 2 inch turnback on 45 degree angle with enclosed welded ends. Front and sides to have marine edge. Refer to Drawing for typical tabletop construction details.
- d. Provide fabricated stainless steel Drip Trough, size and shape as

shown on Drawings. Drip Trough shall be constructed of 14 gauge, stainless steel and be fully welded and press formed. Provide Drip Trough with drain located at the center. Drain to be 1 inch chrome plated. Bottom will incline towards drain at an angle to allow liquid flow toward drain. Provide Drip Trough with removable splash proof grates, maximum length of 24". Grate will be constructed of 14 gauge stainless steel and fabricated to fit inside Trough. Grate will set flush with top of Drip Trough.

- e. Reference the listing of approved fabricators in Section 2.3; Fabricated Metal Equipment of this specification.

2.8.2.115 129. WORK COUNTER W/DRIP TROUGH

- a. Atlanta Custom Fabricator
- b. Provide fabricated stainless steel Work Counter W/Drip Trough, provide with hinged doors, intermediate shelf and bottom shelf, size and shape as shown on Drawings. See section detail 1/QF701.
- c. Where adjacent to wall provide with a typical 4 inch high backsplash with 2 inch turnback on 45 degree angle with enclosed welded ends. Front and sides to have marine edge. Refer to Drawing for typical tabletop construction details.
- d. Provide fabricated stainless steel Drip Trough, size and shape as shown on Drawings. Drip Trough shall be constructed of 14 gauge, stainless steel and be fully welded and press formed. Provide Drip Trough with drain located at the center. Drain to be 1 inch chrome plated. Bottom will incline towards drain at an angle to allow liquid flow toward drain. Provide Drip Trough with removable splash proof grates, maximum length of 24". Grate will be constructed of 14 gauge stainless steel and fabricated to fit inside Trough. Grate will set flush with top of Drip Trough.
- e. Reference the listing of approved fabricators in Section 2.3; Fabricated Metal Equipment of this specification.

2.8.2.116 131. SERVING COUNTER - TRADITIONAL LINE

- a. Atlanta Custom Fabricator
- b. Provide fabricated 16-gauge stainless steel base serving counter. Knee wall with finish to be provided by architect / interiors.
- c. Fabricated counter to be provided with quartz countertop as selected by Architect. Refer to architectural drawings and specifications for selection.
- d. Provide with 10" stainless steel apron to mount equipment controls. Provide cut-outs and openings for equipment, undershelves, and 1 5/8 diameter legs where shown on plans. Reference drawings for serving counter construction. See section detail 3/QF701.
- e. Working height shall be 34" unless detailed otherwise.
- f. Provide fabricated stainless steel Drip Trough, size and shape as shown on Drawings. Drip Trough shall be constructed of 14 gauge, stainless steel and be fully welded and press formed. Provide Drip

Trough with drain located at the center. Drain to be 1 inch chrome plated. Bottom will incline towards drain at an angle to allow liquid flow toward drain. Provide Drip Trough with removable splash proof grates, maximum length of 24". Grate will be constructed of 14 gauge stainless steel and fabricated to fit inside Trough. Grate will set flush with top of Drip Trough.

- g. Provide 3" opening with grommet in countertop for counter top equipment.
- h. Reference the listing of approved fabricators in Section 2.3; Fabricated Metal Equipment of this specification.

2.8.2.117 132. PLATE AND DISH DISPENSER, DROP-IN

- a. Caddy Model No. CM-40*C014
- b. Caddy Magic Dish Dispenser, drop in, open style, unheated, (1) self-leveling adjustable dispensing cylinder, approximate dish size 9-5/8" to 10-1/8" dia., stainless steel construction, NSF.
- c. Products manufactured by Delfield & Vollrath, modified to comply with specifications, are acceptable.

2.8.2.118 133. CARVING STATION / SHELF

- a. Hatco Model No. DCSB400-2420-1*C014
- b. Carving Station with Single Heat Lamp (clear bulb included), telescoping clearance (bottom of shade to top of cutting board) 14" - 26", 30° shade pivot, heated base with thermostatic control, includes one 24"x20" cutting board with meat juice containment, CE, cULus, UL EPH Classified.
- c. Provide unit with the following:
 - 1) Shade & Post Finish - Color as selected by Architect/Interiors
 - 2) Base & Cutting Board - Color as selected by Architect/Interiors.
- d. Products manufactured by Alto-Shaam & Cres Cor, modified to comply with specifications, are acceptable.

2.8.2.119 134. BREATH GUARD

- a. BSI Model No. ZG9930 SERIES*C014
- b. Food Shield, single, full service, fully adjustable, 20-1/4" height, 14" wide tempered glass top & 20" lower sneeze guard, 1" diameter tubing single supports, cULus.
- c. Provide unit with the following:
 - 1) Food Shield Length & Segments per plans
 - 2) 705 Warmer & Light Combo
- d. Finish & mounting style as selected by Architect / Interiors.

- e. Products manufactured by Versa-Gard & English Mfg., modified to comply with specifications, are acceptable.

2.8.2.120 135. DROP-IN HOT/COLD/FREEZE WELL

- a. Duke Model No. HCF-3*C014
- b. Hot/Cold/Freeze Drop-In Food Well Unit, heated & refrigerated, 49" long, (3) 12" x 20" individual pans, 300 series stainless steel top rim, 5" deep 300 series stainless steel interior liners, steel exterior housing, individual wired remote digital controls for hot or cold operation, air-cooled condensing unit, individual drains manifolded to a valve, 6' cord & plug, UL, cULus, NSF #4 & 7.
- c. Products manufactured by LTI, modified to comply with specifications, are acceptable.

2.8.2.121 136. DROP-IN HOT/COLD/FREEZE WELL

- a. Duke Model No. HCF-2*C014
- b. Hot/Cold/Freeze Drop-In Food Well Unit, heated & refrigerated, 34" long, (2) 12" x 20" individual pans, 300 series stainless steel top rim, 5" deep 300 series stainless steel interior liners, steel exterior housing, individual wired remote digital controls for hot or cold operation, air-cooled condensing unit, individual drains manifolded to a valve, 6' cord & plug, UL, cULus, NSF #4 & 7.
- c. Products manufactured by LTI, modified to comply with specifications, are acceptable.

2.8.2.122 137. HEATED DISPLAY

- a. Vollrath Model No. 40734*C014
- b. Hot Food Merchandiser, counter top, self-service, 36"W x 19"D x 25"H, illuminated, (3) adjustable shelves, thermostatically controlled heat 85° - 175°F temp range with humidity, front & rear sliding glass doors, (locking), 1400 watts, cord with NEMA 5-15P, ETL-Sanitation, CETLus.
- c. Products manufactured by Hatco, modified to comply with specifications, are acceptable.

2.8.2.123 138. BREAD DISPLAY CASE

- a. Vollrath Model No. XLBC3F-1826-13*C014
- b. Display Case, countertop, 3-tier, 28-1/2"W x 23-1/2"D x 32-3/4"H, (3) 18" x 26" clear trays, front (3 individual) doors with soft down hinges, 1/2" acrylic, must ship LTL, NSF.
- c. Products manufactured by Cal-Mil & Winco, modified to comply with specifications, are acceptable.

2.8.2.124 139. CONVEYOR TOASTER

- a. Hatco Model No. TQ3-900*C014

- b. Conveyor Toaster, countertop design, horizontal conveyor, touchscreen controls, (12) programmable recipes, all bread types toaster, approximately 15 slices/min capacity, USB, power save mode, toast delivery rack, 2" opening height, cULus, UL EPH Classified, CE.
- c. Provide unit with the following:
 - 1) Black side panels.
- d. Products manufactured by Waring & APW Wyott modified to comply with specifications, are acceptable.

2.8.2.125 140. DROP-IN REFRIGERATED MERCHANDISER

- a. Piper Products Model No. OTR-1*C014
- b. Cold Food Display Case, drop-in, 32 1/3" L, self-serve, (3) intermediate glass shelves, recessed base, stainless steel top, rear glass doors & side panels, 30 1/4" above counter, 27 3/8" below counter, stainless steel frame, self- contained refrigeration, 1/2 HP.
- c. Provide unit with the following
 - 1) Lockable Front roll down night cover.
 - 2) LED Lighted Shelves.
 - 3) Glass Shelves, inclined, with stainless steel end stop.
- d. Products manufactured by Delfield modified to comply with specifications, are acceptable.

2.8.2.126 143. SERVING COUNTER - SPECIALTY FOOD

- a. Atlanta Custom Fabricator
- b. Provide fabricated stainless steel cabinet base Serving Counter, size and shape as shown on Drawings. Counter to be provided with intermediate and bottom shelf, hinged stainless steel doors & louvered access doors where shown on Elevations. Working height shall be 34" unless detailed otherwise.
- c. Fabricated counter to be provided with quartz countertop and 4" backsplash/endsplash as selected by Architect. Refer to architectural drawings and specifications for selection.
- d. Customer exposed surfaces of cabinet and hinged doors to receive laminate finish as selected by Architect. Refer to architectural drawings and specifications for selections.
- e. Provide cutouts and underbracing for equipment shown.
- f. Provide stainless steel 6" kickplate.
- g. Provide 3" opening with grommet in countertop for countertop equipment.
- h. Reference the listing of approved fabricators in Section 2.3; Fabricated Metal Equipment of this specification.

2.8.2.127 144. PLATE DISPENSER

- a. Caddy Model No. CM-40*C014
- b. Dish Dispenser, drop in, open style, unheated, (1) self-leveling adjustable dispensing cylinder, approximate dish size 9-5/8" to 10-1/8" dia., stainless steel construction, NSF.
- c. Products manufactured by Delfield & Vollrath, modified to comply with specifications, are acceptable.

2.8.2.128 145. BREATH GUARD

- a. BSI Model No. ZG9950 SERIES*C014
- b. Food Shield, single, self service, , 20-1/2" height, 14" wide tempered glass top & 10" lower sneeze guard, 1-1/2" diameter tubing double supports, cULus.
- c. Provide unit with the following:
 - 1) Food Shield Length & Segments per plans
 - 2) 705 Warmer & Light Combo
- d. Finish & mounting style as selected by Architect / Interiors.
- e. Products manufactured by Versa-Gard & English Mfg., modified to comply with specifications, are acceptable.

2.8.2.129 146. DROP-IN HOT / COLD / FREEZE

- a. Duke Model No. HCF-5*C014
- b. Duke Manufacturing Model No. HCF-5
- c. Hot/Cold/Freeze Drop-In Food Well Unit, heated & refrigerated, 80" long, (5) 12" x 20" individual pans, 300 series stainless steel top rim, 5" deep 300 series stainless steel interior liners, steel exterior housing, individual wired remote digital controls for hot or cold operation, air-cooled condensing unit, individual drains manifolded to a valve, 6' cord & plug NEMA #14-30P, 208 volt, 60 hrz, 1 phase, 18 amps, UL, cULus, NSF #4 & 7.
- d. Products manufactured by LTI, modified to comply with specifications, are acceptable.

2.8.2.130 147. HOT BEVERAGE DISPENSER

- a. By Product Supplier

2.8.2.131 148. JUICE DISPENSER

- a. By Product Supplier

2.8.2.132 149. CUP DISPLAY

- a. By Owner

2.8.2.133 150. ICE CREAM MACHINE

- a. Taylor Company Model No. C161*C014
- b. Soft Serve Freezer, counter model, self-contained, compact twin twist, (2) 8 qt. hoppers, (2) 1.5 qt. freezing cylinders, indicator lights, Softech™ electronic controls, standby mode, air filter, door interlock system, stainless steel finish, R404A, (2) 1/2 HP motors, NSF, cULus listed.
- c. Provide unit with the following:
 - 1) Air-cooled
 - 2) Cone dispenser kit.
 - 3) Kit-legs with air skirt.
- d. Products manufactured by Stoelting & Frosty Factory, modified to comply with specifications, are acceptable.

2.8.2.134 151. SERVING COUNTER - SALAD BAR

- a. Atlanta Custom Fabricator
- b. Provide fabricated stainless steel cabinet base Serving Counter, size and shape as shown on Drawings. Counter to be provided with intermediate and bottom shelf, hinged stainless steel doors & louvered access doors where shown on Elevations. Working height shall be 34" unless detailed otherwise.
- c. Fabricated counter to be provided with quartz countertop with 4" backsplash/endsplash as selected by Architect. Refer to architectural drawings and specifications for selection.
- d. Customer exposed surfaces of cabinet and hinged doors to receive laminate finish as selected by Architect. Refer to architectural drawings and specifications for selections.
- e. Provide cutouts and underbracing for equipment shown.
- f. Provide stainless steel 6" kickplate.
- g. Provide 3" opening with grommet in countertop for countertop equipment.
- h. Reference the listing of approved fabricators in Section 2.3; Fabricated Metal Equipment of this specification.

2.8.2.135 152. PLATE DISPENSER

- a. Caddy Model No. CM-40*C014
- b. Dish Dispenser, drop in, open style, unheated, (1) self-leveling adjustable dispensing cylinder, approximate dish size 9-5/8" to 10-1/8" dia., stainless steel construction, NSF.
- c. Products manufactured by Delfield & Vollrath, modified to comply with

specifications, are acceptable.

2.8.2.136 153. BREATH GUARD

- a. BSI Model No. ZG9950*C014
- b. Food Shield, single, self service, , 20-1/2" height, 14" wide tempered glass top & 10" lower sneeze guard, 1-1/2" diameter tubing double supports, cULus.
- c. Provide unit with the following:
 - 1) Food Shield Length & Segments per plans
 - 2) 2580 LED lights
- d. Finish & mounting style as selected by Architect / Interiors.
- e. Products manufactured by Versa-Gard & English Mfg., modified to comply with specifications, are acceptable.

2.8.2.137 154. DROP-IN COLD WELL

- a. Duke Model No. ADI-5MD-N7*C014
- b. Drop-In Cold Food Pan, refrigerated, 74-7/8"W x 25-1/2"D x 26"H, accommodates (5) 6" deep 12" x 20" pans, 300 series stainless steel top with overhang & locking tabs, 10" deep 300 series stainless steel interior liner, steel exterior housing, remote mounted on/off switch with stainless steel face plate (2-3/16"W x 4-1/8"H cutout required), air-cooled condensing unit, (4) adapter bars included, 1" brass drain & plug, R448a, UL EPH Classified, cULus (73-1/2"W x 24-3/4"D cutout required for unit).
- c. Products manufactured by LTI, modified to comply with specifications, are acceptable.

2.8.2.138 155. SMOOTHIE MACHINE

- a. By Product Supplier

2.8.2.139 156. NOVALTY ICE CREAM COUNTER

- a. Atlanta Custom Fabricator
- b. Provide fabricated stainless steel cabinet base Novalty Ice Cream Counter with two ice cream drop-ins added into the body at the ends with a recessed pan/area in the middle for the condiments and bowls. Counter to be provided with bottom shelf and stainless steel louvered access doors where shown on drawings. Size and shape as shown on Drawings.
- c. Working height shall be 34" unless detailed otherwise.
- d. Fabricated counter to be provided with quartz countertop as selected by Architect. Refer to architectural drawings and specifications for selection.
- e. Customer exposed surfaces of cabinet and hinged doors to receive

laminate finish as selected by Architect. Refer to architectural drawings and specifications for selections.

- f. 6" swivel casters (2 with brakes).
- g. Reference the listing of approved fabricators in Section 2.3; Fabricated Metal Equipment of this specification.

2.8.2.140 157. BREATH GUARD

- a. BSI Model No. ZG9950*C014
- b. Food Shield, single, full service, fully adjustable, 20-1/2" height, 14" wide tempered glass top & 20" lower sneeze guard, 1" diameter tubing double supports, cULus.
- c. Provide unit with the following:
 - 1) Food Shield Length & Segments per plans
 - 2) 2580 LED lighting
- d. Finish & mounting style as selected by Architect / Interiors.
- e. Products manufactured by Versa-Gard & English Mfg., modified to comply with specifications, are acceptable.

2.8.2.141 158. FREEZER, DROP-IN

- a. Silver King Model No. SKFDI23-ELUS1*C014
- b. Ice Cream Display Freezer, drop-in, (1) hinged glass lid, adjustable temperature control, manual defrost, stainless steel interior, stainless steel & galvanized exterior, bottom-mounted self-contained refrigeration, R290, NEMA 5-15P, cETLus, ETL-Sanitation.
- c. Products manufactured by Delfield & LTI, modified to comply with specifications, are acceptable.

2.8.2.142 161. WORK COUNTER W/SINK

- a. Millwork
- b. (Item No.161.1) Drop-In Sink Advance Tabco Model No.DI-1-1515*C014
 - 1) Drop-In Sink, 1-compartment, 15"W x 15"D x 6" deep (overall), 12-1/4" wide x 10-1/4" front-to-back x 6" deep bowl, no drip self-rimmed edge, 20/304 stainless steel, with 4" on-center deck mounted gooseneck faucet, 3-1/2" basket drain with strainer, NSF.
 - 2) K-520MIT To Delete Faucet.
 - 3) (Item No.161.2) Faucet T&S Brass Model No. B-0325-CC-CR Mixing Faucet, deck mount, 4" adjustable centers, 5-3/4" swivel gooseneck spout with Series 1 stream regulator outlet (includes lock washer to convert to rigid), lever handles with color coded indexes, quarter-turn Cerama cartridges with check valves, polished chrome plated brass body, 1/2" NPT male inlets, low lead, cCSAus, ADA Compliant.

- 4) B-0199-01 Aerator, non-splash, 55/64" -27 female aerator threads, fits goosenecks & nozzles.
- 5) (Item No.161.3) Drip Trough Atlanta Custom Fabricator, Provide fabricated stainless steel Drip Trough, size and shape as shown on Drawings. Drip Trough shall be constructed of 14 gauge, stainless steel and be fully welded and press formed. Provide Drip Trough with drain located at the center. Drain to be 1 inch chrome plated. Bottom will incline towards drain at an angle to allow liquid flow toward drain. Provide Drip Trough with removable splash proof grates, maximum length of 24". Grate will be constructed of 14 gauge stainless steel and fabricated to fit inside Trough. Grate will set flush with top of Drip Trough.

- c. Products manufactured by Eagle & John Boos, modified to comply with specifications, are acceptable.

2.8.2.143 162. COFFEE BREWER

- a. By Product Supplier

2.8.2.144 163. TEA BREWER

- a. By Product Supplier

2.8.2.145 164. UNDERCOUNTER SODA SYSTEM & CARBONATOR

- a. By Product Supplier

2.8.2.146 165. SERVING COUNTER - ROTC LINE

- a. Atlanta Custom Fabricator
- b. Provide fabricated 16-gauge stainless steel base serving counter. Knee wall with finish to be provided by architect / interiors.
- c. Fabricated counter to be provided with quartz countertop as selected by Architect. Refer to architectural drawings and specifications for selection.
- d. Provide with 10" stainless steel apron to mount equipment controls. Provide cut-outs and openings for equipment, undershelves, and 1 5/8 diameter legs where shown on plans. Reference drawings for serving counter construction. See section detail 3/QF701.
- e. Working height shall be 34" unless detailed otherwise.
- f. Provide fabricated stainless steel Drip Trough, size and shape as shown on Drawings. Drip Trough shall be constructed of 14 gauge, stainless steel and be fully welded and press formed. Provide Drip Trough with drain located at the center. Drain to be 1 inch chrome plated. Bottom will incline towards drain at an angle to allow liquid flow toward drain. Provide Drip Trough with removable splash proof grates, maximum length of 24". Grate will be constructed of 14 gauge stainless steel and fabricated to fit inside Trough. Grate will set flush with top of Drip Trough.
- g. Provide 3" opening with grommet in countertop for counter top

equipment.

- h. Reference the listing of approved fabricators in Section 2.3; Fabricated Metal Equipment of this specification.

2.8.2.147 166. DROP-IN REFRIGERATED DISPLAY

- a. Piper Products Model No. OTR-3*C014
- b. Cold Food Display Case, drop-in, 58"L, self-serve, (3) intermediate glass shelves, recessed base, stainless steel top, rear glass doors & side panels, 30 1/4" above counter, 27 3/8" below counter, stainless steel frame, self- contained refrigeration, 1-1/2 HP.
- c. Provide unit with the following:
 - 1) Lockable Front roll down night cover.
 - 2) LED Lighted Shelves.
 - 3) IS Glass Shelves, inclined, with stainless steel end stop.
- d. Products manufactured by Delfield, modified to comply with specifications, are acceptable.

2.8.2.148 167. PLATE AND DISH DISPENSER, DROP-IN

- a. Caddy Model No. CM-40*C014
- b. Caddy Magic Dish Dispenser, drop in, open style, unheated, (1) self-leveling adjustable dispensing cylinder, approximate dish size 9-5/8" to 10-1/8" dia., stainless steel construction, NSF.
- c. Products manufactured by Delfield & Vollrath, modified to comply with specifications, are acceptable.

2.8.2.149 168. BREATH GUARD

- a. BSI Model No. ZG9930*C014
- b. Food Shield, single, full service, fully adjustable, 20-1/2" height, 14" wide tempered glass top & 20" lower sneeze guard, 1" diameter tubing double supports, cULus.
- c. Provide unit with the following:
 - 1) Food Shield Length & Segments per plans
 - 2) 705 Warmer & Light Combo.
- d. (Item No. 168.1) ZGUARD Food Shield, single, full service, fully adjustable, 20-1/2" height, 14" wide tempered glass top & 20" lower sneeze guard, 1" diameter tubing double supports, cULus.
 - 1) Food Shield Length & Segments per plan
 - 2) 705 Warmer & Light Combo
- e. Finish & mounting style as selected by Architect / Interiors.

- f. Products manufactured by Versa-Gard & English Mfg., modified to comply with specifications, are acceptable.

2.8.2.150 169. DROP-IN HOT/COLD/FREEZE WELL

- a. Duke Model No. HCF-3*C014
- b. Hot/Cold/Freeze Drop-In Food Well Unit, heated & refrigerated, 49" long, (3) 12" x 20" individual pans, 300 series stainless steel top rim, 5" deep 300 series stainless steel interior liners, steel exterior housing, individual wired remote digital controls for hot or cold operation, air-cooled condensing unit, individual drains manifolded to a valve, 6' cord & plug, UL, cULus, NSF #4 & 7.
- c. Products manufactured by LTI, modified to comply with specifications, are acceptable.

2.8.2.151 170. DROP-IN HOT/COLD/FREEZE WELL

- a. Duke Model No. HCF-3*C014
- b. Hot/Cold/Freeze Drop-In Food Well Unit, heated & refrigerated, 49" long, (3) 12" x 20" individual pans, 300 series stainless steel top rim, 5" deep 300 series stainless steel interior liners, steel exterior housing, individual wired remote digital controls for hot or cold operation, air-cooled condensing unit, individual drains manifolded to a valve, 6' cord & plug, UL, cULus, NSF #4 & 7.
- c. Products manufactured by LTI, modified to comply with specifications, are acceptable.

2.8.2.152 171. DROP-IN REFRIGERATED MERCHANDISER

- a. Piper Products Model No. OTR-1*C014
- b. Cold Food Display Case, drop-in, 32 1/3" L, self-serve, (3) intermediate glass shelves, recessed base, stainless steel top, rear glass doors & side panels, 30 1/4" above counter, 27 3/8" below counter, stainless steel frame, self-contained refrigeration, 1/2 HP.
- c. Provide unit with the following:
 - 1) Lockable Front roll down night cover.
 - 2) LED Lighted Shelves.
 - 3) Glass Shelves, inclined, with stainless steel end stop.
- d. Products manufactured by Delfield, modified to comply with specifications, are acceptable.

2.8.2.153 172. CUP DISPLAY

- a. By Owner

2.8.2.154 173. SODA DISPENSER

- a. By Product Supplier

2.8.2.155 174. JUICE DISPENSER

- a. By Product Supplier

2.8.2.156 175. HOT BEVERAGE DISPENSER

- a. By Product Supplier

2.8.2.157 176. CUP DISPLAY

- a. By Owner

2.8.2.158 177. TEA URN

- a. By Product Supplier

2.8.2.159 178. COFFEE WARMER W/ THERMAL SERVER

- a. By Product Supplier

2.8.2.160 179. POINT OF SALE

- a. By Owner

2.8.2.161 180. ENCLOSED TRANSPORT CABINET

- a. Cres Cor Model No. 103UA13D*C014
- b. Cabinet, mobile, enclosed, single compartment, non-insulated, hold (13) sets universal angles pan slides on adjustable 1-1/2" centers, reinforced door swings 270°, gravity type latch, card clip included, (4) 5" swivel casters (2) braked, Hi-Tensile aluminum exterior & interior, NSF.
- c. Products manufactured by New Age & FWE, modified to comply with specifications, are acceptable.

PART 3 EXECUTION

3.1 LABELING AND IDENTIFICATION

Clearly label and identify all components with respective number as enumerated in approved Food Service Equipment Schedule. Provide equipment with tags numbered and stamped for their use as indicated on the Food Service Equipment Schedule. Provide brass or non-ferrous plates and tags. Minimum letter and numeral sizes are 1/8 inch high.

-- End of Section --

SECTION 21 13 00.00 40

FIRE-SUPPRESSION SPRINKLER SYSTEMS

08/13, CHG 1: 11/14

PART 1 GENERAL

Section 23 30 00 HVAC AIR DISTRIBUTION applies to work specified in this section.

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN IRON AND STEEL INSTITUTE (AISI)

AISC/AISI 121 (2007) Standard Definitions for Use in the Design of Steel Structures

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME A112.18.1/CSA B125.1 (2018) Plumbing Supply Fittings

ASME B16.1 (2020) Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250

ASME B16.3 (2021) Malleable Iron Threaded Fittings, Classes 150 and 300

ASME B16.4 (2021) Gray Iron Threaded Fittings; Classes 125 and 250

ASME B16.9 (2018) Factory-Made Wrought Buttwelding Fittings

ASME B16.34 (2021) Valves - Flanged, Threaded and Welding End

ASME B16.39 (2020) Standard for Malleable Iron Threaded Pipe Unions; Classes 150, 250, and 300

ASME B31.1 (2022) Power Piping

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C104/A21.4 (2016) Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water

AWWA C111/A21.11 (2017) Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings

AWWA C151/A21.51 (2017) Ductile-Iron Pipe, Centrifugally Cast

ASTM INTERNATIONAL (ASTM)

ASTM A53/A53M	(2022) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A126	(2004; R 2019) Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A135/A135M	(2021) Standard Specification for Electric-Resistance-Welded Steel Pipe
ASTM A183	(2014; R 2020) Standard Specification for Carbon Steel Track Bolts and Nuts
ASTM A197/A197M	(2000; R 2019) Standard Specification for Cupola Malleable Iron
ASTM A234/A234M	(2022) Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service
ASTM A307	(2021) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM A563	(2021; E 2022a) Standard Specification for Carbon and Alloy Steel Nuts
ASTM B370	(2022) Standard Specification for Copper Sheet and Strip for Building Construction
ASTM B749	(2020) Standard Specification for Lead and Lead Alloy Strip, Sheet and Plate Products
ASTM C592	(2022a) Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type)
ASTM C920	(2018) Standard Specification for Elastomeric Joint Sealants
ASTM D2000	(2018) Standard Classification System for Rubber Products in Automotive Applications

FM GLOBAL (FM)

FM APP GUIDE	(updated on-line) Approval Guide http://www.approvalguide.com/

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS
INDUSTRY (MSS)

MSS SP-58	(2018) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 13	(2022; ERTA 3 2022) Standard for the Installation of Sprinkler Systems
NFPA 13E	(2020) Recommended Practice for Fire Department Operations in Properties Protected by Sprinkler and Standpipe Systems
NFPA 14	(2019; TIA 19-1) Standard for the Installation of Standpipes and Hose Systems
NFPA 24	(2022) Standard for the Installation of Private Fire Service Mains and Their Appurtenances
NFPA 70	(2023) National Electrical Code
NFPA 1963	(2019) Standard for Fire Hose Connections

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

SAE AMS-STD-595A	(2017) Colors used in Government Procurement

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-C-18480	(1982; Rev B; Notice 2 2009; Notice 3 2022) Coating Compound, Bituminous, Solvent, Coal-Tar Base
MIL-STD-101	(2014; Rev C) Color Code for Pipelines and for Compressed Gas Cylinders

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FS FF-S-325	(Basic; Int Amd 3; Notices 3, 4) Shield, Expansion; Nail, Expansion; and Nail, Drive Screw (Devices, Anchoring, Masonry)

UNDERWRITERS LABORATORIES (UL)

UL 6	(2022) UL Standard for Safety Electrical Rigid Metal Conduit-Steel

1.2 ADMINISTRATIVE REQUIREMENTS

Conduct a survey of the work area. Submit a [record of existing conditions](#) showing the results of the survey of work area conditions and features of existing structures and facilities within and adjacent to the jobsite. Commencement of work constitutes acceptance of existing conditions.

1.3 SUBMITTALS

Government approval is required for submittals . Submit the following in accordance with Section [01 33 00](#) SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Record of Existing Conditions

SD-02 Shop Drawings

Supporting Elements

Fire-Department Connections

Sprinkler Heads

Valves

SD-03 Product Data

Underground Piping Materials

Aboveground Piping Materials

Valves

Fire-Department Connections

Riser Alarm Equipment

Sprinkler Heads

Materials

Supporting Elements

Equipment and Performance Data

Equipment Labels

Equipment-Label Schedule

SD-05 Design Data

Design Analysis and Calculations

SD-06 Test Reports

Pressure Tests

System Operating Tests

Air Tests

Valve-Operating Tests

Drainage Tests

SD-10 Operation and Maintenance Data

Valve Schedules

Equipment-Label Schedule

PART 2 PRODUCTS

Provide design analysis and calculations in accordance with NFPA 13.

Submit connection diagrams indicating the relations and connections of the following items. Indicate on drawings, the general physical layout of all controls, and internal tubing and wiring details.

2.1 SYSTEM DESCRIPTION

Ensure fire-protection system materials and equipment provided under this section conform to the requirements of Underwriters Laboratories (UL) or the Factory Mutual (FM APP GUIDE).

Products with UL label or seal or listing in UL 6, and products with FM label or listed in the FM APP GUIDE are acceptable fire-protection system materials and equipment. Furnish materials and equipment compatible with existing system.

Submit equipment and performance data for fire protection sprinkler systems consisting of information on use life, system functional flows, safety features, and mechanical automated details.

2.2 EQUIPMENT

2.2.1 Underground Piping Materials

Provide ells, tees, reducing tees, wyes, couplings, increasers, crosses, transitions, and end caps of the same type and class of material as the pipe or have equal or superior physical and chemical properties.

2.2.1.1 Type Ductile Iron Water Pipe

Provide mechanical-joint or push-on type ductile-iron water pipe, centrifugally cast, UL listed and labeled, conforming to applicable provisions of AWWA C111/A21.11, and AWWA C151/A21.51. Wall-thickness criteria is 200-pounds per square inch (psi) working pressure plus 100-psi surge allowance, AASHTO H-20 loading with specified trench conditions. Ensure the gasket elastomer is chloroprene.

Coat pipe on the inside with a bituminous sealer in accordance with AWWA C104/A21.4.

Restraining joints against endwise separation due to internal pressure may be accomplished by using a metal harness consisting of clamping devices and bolting or by hardened-metal retainers molded into a pushon gasket and engaged by a groove in the spigot end.

Where electrical continuity is indicated, supply the pipe with factory-brazed heavy cross section copper connectors to be joined with copper fasteners upon joint assembly. Connectors, at a minimum, are equal to No. 1/0.

2.2.2 Aboveground Piping Materials

2.2.2.1 Type BCS - Black Carbon Steel

Pipe 1/8 through 1-1/2 inches: Schedule 40 furnace butt weld black-carbon

steel conforming to [ASTM A53/A53M](#), or [ASTM A135/A135M](#), Type F furnace butt welded; Schedule 10 conforming to [ASTM A135/A135M](#), Grade B.

Pipe [2 through 8 inches](#), where indicated: Schedule 40 seamless or electric-resistance welded black carbon steel, conforming to [ASTM A53/A53M](#) or [ASTM A135/A135M](#), Type E (electric-resistance welded), Grade B, or Type S (seamless), Grade B; Schedule 10 conforming to [ASTM A135/A135M](#), Grade B.

Unions [2 inches](#) and under): [300-pound per square inch gage \(psig\)](#) working steam pressure (wsp) female, screwed, black malleable iron, with ground joint and brass-to-iron seat conforming to [ASME B16.39](#).

Standard pipe couplings: Extra-heavy screwed black steel.

Grooved pipe couplings (all sizes): [175-psig](#) minimum working pressure with a housing fabricated in two or more parts of black malleable-iron castings. Provide coupling gasket molded of synthetic rubber, conforming to requirements of [ASTM D2000](#). Provide coupling bolts that are oval-neck, track-head type with heavy hexagonal nuts, conforming to [ASTM A183](#).

Fittings [4 inches](#) and under: [175-psig](#) working pressure, cast iron, screwed, conforming to [ASTM A126](#), Class A, and [ASME B16.4](#).

Fittings [6 inches](#) and larger: [175-psig](#) working pressure, cast iron, conforming to [ASTM A126](#), Class A, screwed, conforming to [ASME B16.4](#), or flanged, conforming to [ASME B16.1](#).

Fittings [8 inches](#) and under): Provide rolled-groove or mechanical locking (push-on) couplings. Provide rolled only grooves for rolled-groove type; cut grooving is not allowed. Ensure rolled grooves are dimensionally compatible with the couplings.

Grooved fittings (all sizes): ensure [175-psig](#) working pressure fittings used with grooved couplings are fabricated of black malleable-iron castings. If a manufacturer's standard-size malleable-iron fitting pattern is not available, use fabricated fittings. Fabricate fittings from Grade B seamless-steel pipe and long-radius seamless welding fittings, with wall thickness to match pipe, conforming to [ASTM A234/A234M](#) and [ASME B16.9](#).

2.2.2.2 Type GCS - Galvanized Carbon Steel

Pipe [1/2 through 10 inches](#) and where indicated): Schedule 40 seamless or electric resistant welded galvanized steel conforming to [ASTM A53/A53M](#), Type E (electric-resistance welded) or Type S (seamless). Type F (furnace butt welded continuous welded) is acceptable for sizes less than [2 inches](#).

Fittings (all sizes): [150-psig](#) working pressure banded, galvanized, malleable, screwed, conforming to [ASTM A197/A197M](#) and [ASME B16.3](#).

Fittings [2-1/2 inches](#) and over): [125-psig](#) working pressure cast-iron flanges and flanged fittings conforming to [ASTM A126](#), Class A and to [ASME B16.1](#).

Grooved pipe couplings (all sizes): [175-psig](#) minimum working pressure with a housing fabricated in two or more parts of galvanized malleable-iron castings. Provide coupling gasket molded of synthetic rubber, conforming to requirements of [ASTM D2000](#). Ensure coupling bolts are oval-neck, track-head type with heavy hexagonal nuts, conforming to

ASTM A183.

Grooved fittings (all sizes): ensure 175-psig working pressure fittings used with grooved couplings are fabricated of galvanized malleable-iron castings. If a manufacturer's standard-size malleable-iron fitting pattern is not available, use fabricated fittings. Fabricate fittings from Grade B seamless steel pipe and long-radius seamless welding fittings, with wall thickness to match pipe, conforming to ASTM A234/A234M and ASME B16.9.

Unions 2 inches and under): 300-psig working pressure female, screwed, galvanized malleable iron, with brass-to-seat and ground joint.

2.2.2.3 Pe Pipe And Fittings

- a. PE, Fire-Service Pipe: FM Global approved, with minimum thickness equivalent to Class 150 and Class 200.
- b. Molded PE Fittings: FM Global approved; PE butt-fusion type, made to match PE pipe dimensions and class.

2.2.2.4 Pvc Pipe And Fittings

- a. PVC Pipe: AWWA C900 or UL 1285, Class 150 and Class 200, with bell end with gasket, and with spigot end.
- b. PVC Fittings: AWWA C900 or UL 1285, Class 150 and Class 200, with bell-and-spigot or double-bell ends. Include elastomeric gasket in each bell.

2.2.3 Supporting Elements

Provide piping system components and miscellaneous supporting elements, including, but not limited to, building-structure attachments; supplementary steel; hanger rods, stanchions, and fixtures; vertical-pipe attachments; horizontal-pipe attachments; restraining anchors; and guides. Ensure supporting elements are suitable for stresses imposed by systems pressures and temperatures, natural, and other external forces.

Provide FM approved or UL listed supporting elements conforming to ASME B31.1, MSS SP-58, and ASME B16.34.

2.2.3.1 Building-Structure Attachments

For cast-in floor-mounted equipment-anchor devices, ensure adjustable positions are available.

Do not use powder-actuated anchoring devices to support mechanical-systems components.

- a. Anchor Devices, Concrete and Masonry
 - (1) Ensure anchor devices conform to FS FF-S-325:
 - (2) Group I: Shield, expansion (lead, bolt, and stud anchors)
 - (3) Group II: Shield, expansion (bolt anchors), Type 2, Class 2, Style 1 or 2

- (4) Group III: Shield, expansion (self drilling tubular expansion shell bolt anchors

b. Beam Clamps

- (1) Provide center-loading beam clamps, Types 21, 28, 29, and 30, UL listed, cataloged, and load-rated commercially manufactured products.
- (2) Use Type 20 beam clamps for pipe 2 inches and under.
- (3) Use two Type 25 beam clamps per point of pipe support.

c. C-Clamps

- (1) Ensure C-clamps are used to support piping sizes 1-1/2 inches and smaller. Use FM approved and UL listed C-clamps, with hardened cup-tip setscrew, locknut, and retaining strap. Retaining-strap section cannot be less than 1/8 by 1 inch. Beam-flange thickness to which clamps are attached cannot exceed 0.60 inch.

d. Concrete Inserts

- (1) Construct concrete inserts in accordance with the requirements of MSS SP-58 for Type 18 and ASME B16.34. When applied to piping in sizes 2-inch iron pipe size (ips) and larger, and where otherwise required by imposed loads, insert and wire a 1-foot length of 1/2-inch reinforcing rod through wing slots.

2.2.3.2 Horizontal-Pipe Attachments

a. Single Pipes

- (1) Support piping in sizes up to and including 2-inch ips by using Type 1, 5, 6, 7, 9, 10, 11, or 12 solid, split-ring, or band type attachments.
- (2) Support piping in sizes 2-1/2 inches and larger by using Type 1, 2, 3, or 4 attachments or with Type 41 or Type 49 pipe rolls.

b. Parallel Fire-Protection Pipes

- (1) Use trapeze hangers fabricated from approved structural steel shapes, with U-bolts, when so specified. Ensure structural-steel shapes conform to supplementary steel requirements or the support is commercially available, approved proprietary-design rolled steel.

2.2.3.3 Vertical-Pipe Attachments

Provide Type B single vertical-pipe attachments.

2.2.3.4 Hanger Rods and Fixtures

Use only circular solid cross section rod hangers to connect building structure attachments to pipe-support devices. Use pipe, straps, or bars of equivalent strength for hangers.

Provide turnbuckles, swing eyes, and clevises as required by support

system to accommodate temperature changes, pipe accessibility, and adjustment for load and pitch.

2.2.3.5 Supplementary Steel

Where it is necessary to frame structural members between existing members or where structural members are used in lieu of commercially rated supports, design such supplementary steel and fabricate in accordance with [AISC/AISI 121](#).

2.2.4 Fire-Department Connections

Ensure hose connections have National Firehose standard-thread form and rocker lugs in accordance with [NFPA 1963](#). Ensure hose-connection sizes and threads are compatible with the equipment used by the fire department serving the facility.

2.2.4.1 Flush-Type Fire-Department Connection

- a. Standard: UL 405.
- b. Type: Flush, for wall mounting.
- c. Pressure Rating: 175 psig minimum.
- d. Body Material: Corrosion-resistant metal.
- e. Inlets: Brass with threads according to NFPA 1963 and matching local fire-department sizes and threads. Include extension pipe nipples, brass lugged swivel connections, and check devices or clappers.
- f. Caps: Brass, lugged type, with gasket and chain.
- g. Escutcheon Plate: Rectangular, brass, wall type.
- h. Outlet: With pipe threads.
- i. Body Style: Horizontal.
- j. Number of Inlets: Three.
- k. Outlet Location: Back.
- l. Escutcheon Plate Marking: Similar to "AUTO SPKR & STANDPIPE."
- m. Finish: Polished chrome plated.
- n. Outlet Size: Per detail.

2.2.5 Riser Alarm Equipment

Ensure riser alarm equipment is UL listed or FM approved for fire-protection use.

2.2.5.1 Wet-Pipe Alarm Check Valve

Provide wet-pipe alarm check valve, complete with standard accessories and trim necessary to give an alarm and includes pressure gages, retard chamber, testing provisions, and all necessary intercomponent piping,

fittings, and valves. Ensure pilot valve and clapper have individual elastomer seats.

2.2.5.2 Standard Check Valve

Provide FM-approved or UL-listed standard swing-check valves with elastomer-disc seat. Provide pressure gages on both sides of the clapper. Water-flow alarm is a vane type.

2.2.5.3 Water-Flow Alarm Device

Ensure water-flow alarm devices are UL listed for the particular type of system.

a. Vane-Type Flow Alarm

- (1) Ensure the vane-type flow alarm makes or breaks an alarm circuit upon deflection by a volume of flowing water that equals or exceeds the capacity of a single sprinkler. Ensure alarm has an instant-recycle pneumatic-retard time delay.

- (2) Water Flow Indicator: Rated for 250-psig working pressure; designed for horizontal or vertical installation; with two single-pole, double-throw circuit switches to provide isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal when cover is removed.

- b. Supervisory Switches: Single pole, double throw; designed to signal valve in other than fully open position.

- c. Pressure Switches: Single pole, double throw; designed to signal increase in pressure.

2.2.6 Sprinkler Heads

2.2.6.1 Head Types

Use standard 1/2-inch orifice sprinkler heads. Heads are automatic on-off type. Install on-off type heads only in wet-pipe systems.

Ensure heads in finished areas below suspended ceilings are flush chrome-plated brass. Provide escutcheon plate of baked enamel finished to match ceiling.

Furnish flush or pendant heads in finished areas below suspended ceiling. Ensure heads and escutcheon plates are chrome-plated brass.

Ensure heads in unfinished areas below suspended ceilings are pendant type. Heads in all other locations are pendant type.

Ensure corrosion-resistant heads are lead-coated.

2.2.6.2 Temperature Rating

Fusible links are for ordinary hazard, except where otherwise indicated.

2.2.6.3 Spares

Furnish spares for each type of sprinkler head, complete with appropriate storage cabinet and wrench.

2.2.6.4 Head Protection

Protect heads with paper or plastic bags during painting operations. Remove protection immediately upon finishing painting operations.

Provide head guards wherever mechanical damage could occur. Guard finish is red enamel.

2.2.7 Valves

2.2.7.1 General Requirements For Valves

- a. UL Listed: Valves shall be listed in UL's "Online Certifications Directory" under the headings listed below and shall bear UL mark:
 - (1) Main Level: HAMV - Fire Main Equipment.
 - (a) Level 1: HCBZ - Indicator Posts, Gate Valve.
 - (b) Level 1: HLOT - Valves.
 - 1. Level 3: HLUG - Ball Valves, System Control.
 - 2. Level 3: HLXS - Butterfly Valves.
 - 3. Level 3: HMER - Check Valves.
 - 4. Level 3: HMRZ - Gate Valves.
 - (2) Main Level: VDGT - Sprinkler System & Water Spray System Devices.
 - (a) Level 1: VQGU - Valves, Trim and Drain.
- b. FM Global Approved: Valves shall be listed in its "Approval Guide," under the headings listed below:
 - (1) Automated Sprinkler Systems:
 - (a) Indicator posts.
 - (b) Valves.
 - 1. Gate valves.
 - 2. Check valves: Single check valves.
 - 3) Miscellaneous valves.
- c. Source Limitations for Valves: Obtain valves for each valve type from single manufacturer.
- d. ASME Compliance:
 - (1) ASME B16.1 for flanges on iron valves.

- (2) ASME B1.20.1 for threads for threaded-end valves.
- (3) ASME B31.9 for building services piping valves.
- e. AWWA Compliance: Comply with AWWA C606 for grooved-end connections.
- f. NFPA Compliance: Comply with NFPA 24 for valves.
- g. Valve Pressure Ratings: Not less than the minimum pressure rating indicated or higher as required by system pressures.
- h. Valve Sizes: Same as upstream piping unless otherwise indicated.
- i. Valve Actuator Types:
 - (1) Worm-gear actuator with handwheel for quarter-turn valves, except for trim and drain valves.
 - (2) Handwheel: For other than quarter-turn trim and drain valves.
 - (3) Handlever: For quarter-turn trim and drain valves NPS 2 and smaller.

2.2.7.2 Two-Piece Ball Valves With Indicators

- a. Description:
 - (1) UL 1091, except with ball instead of disc and FM Global standard for indicating valves (butterfly or ball type), Class Number 1112.
 - (2) Minimum Pressure Rating: 175 psig.
 - (3) Body Design: Two piece.
 - (4) Body Material: Forged brass or bronze.
 - (5) Port Size: Full or standard.
 - (6) Seats: PTFE.
 - (7) Stem: Bronze or stainless steel.
 - (8) Ball: Chrome-plated brass.
 - (9) Actuator: Worm gear or traveling nut.
 - (10) Supervisory Switch: Internal or external.
 - (11) End Connections for Valves NPS 1 through NPS 2: Threaded ends.
 - (12) End Connections for Valves NPS 2-1/2: Grooved ends.

2.2.7.3 Check Valves

- a. Description:
 - (1) Standard: UL 312 and FM Global standard for swing check valves, Class Number 1210.

- (2) Minimum Pressure Rating: 175 psig.
- (3) Type: Single swing check.
- (4) Body Material: Cast iron, ductile iron, or bronze.
- (5) Clapper: Bronze, ductile iron, or stainless steel with elastomeric seal.
- (6) Clapper Seat: Brass, bronze, or stainless steel.
- (7) Hinge Shaft: Bronze or stainless steel.
- (8) Hinge Spring: Stainless steel.
- (9) End Connections: Flanged, grooved, or threaded.

2.2.7.4 Bronze Os&Y Gate Valves

a. Description:

- (1) Standard: UL 262 and FM Global standard for fire-service water control valves (OS&Y- and NRS-type gate valves).
- (2) Minimum Pressure Rating: 175 psig.
- (3) Body and Bonnet Material: Bronze or brass.
- (4) Wedge: One-piece bronze or brass.
- (5) Wedge Seat: Bronze.
- (6) Stem: Bronze or brass.
- (7) Packing: Non-asbestos PTFE.
- (8) Supervisory Switch: External.
- (9) End Connections: Threaded.

2.2.7.5 Iron Os&Y Gate Valves

a. Description:

- (1) Standard: UL 262 and FM Global standard for fire-service water control valves (OS&Y- and NRS-type gate valves).
- (2) Minimum Pressure Rating: 175 psig.
- (3) Body and Bonnet Material: Cast or ductile iron.
- (4) Wedge: Cast or ductile iron, or bronze with elastomeric coating.
- (5) Wedge Seat: Cast or ductile iron, or bronze with elastomeric coating.
- (6) Stem: Brass or bronze.

- (7) Packing: Non-asbestos PTFE.
- (8) Supervisory Switch: External.
- (9) End Connections: Flanged, Grooved, or Threaded.

2.2.7.6 Nrs Gate Valves

a. Description:

- (1) Standard: UL 262 and FM Global standard for fire-service water control valves (OS&Y- and NRS-type gate valves).
- (2) Minimum Pressure Rating: 175 psig.
- (3) Body and Bonnet Material: Cast or ductile iron.
- (4) Wedge: Cast or ductile iron with elastomeric coating.
- (5) Wedge Seat: Cast or ductile iron, or bronze with elastomeric coating.
- (6) Stem: Brass or bronze.
- (7) Packing: Non-asbestos PTFE.
- (8) Supervisory Switch: External.
- (9) End Connections: Flanged, Grooved or Threaded.

2.2.7.7 Indicator Posts

a. Description:

- (1) Standard: UL 789 and FM Global standard for indicator posts.
- (2) Type: Underground, Pit or Wall.
- (3) Base Barrel Material: Cast or ductile iron.
- (4) Extension Barrel: Cast or ductile iron.
- (5) Cap: Cast or ductile iron.
- (6) Operation: Wrench or Handwheel.

2.2.7.8 Trim And Drain Valves

a. Ball Valves:

- (1) Pressure Rating: 175 psig.
- (2) Body Design: Two piece.
- (3) Body Material: Forged brass or bronze.
- (4) Port size: Full or standard.
- (5) Seats: PTFE.

- (6) Stem: Bronze or stainless steel.
- (7) Ball: Chrome-plated brass.
- (8) Actuator: Handlever.
- (9) End Connections for Valves NPS 1 through NPS 2-1/2: Threaded ends.
- (10) End Connections for Valves NPS 1-1/4 and NPS 2-1/2: Grooved ends.

b. Angle Valves:

- (1) Pressure Rating: 175 psig.
- (2) Body Material: Brass or bronze.
- (3) Ends: Threaded.
- (4) Stem: Bronze.
- (5) Disc: Bronze.
- (6) Packing: Asbestos free.
- (7) Handwheel: Malleable iron, bronze, or aluminum.

c. Globe Valves:

- (1) Pressure Rating: 175 psig.
- (2) Body Material: Bronze with integral seat and screw-in bonnet.
- (3) Ends: Threaded.
- (4) Stem: Bronze.
- (5) Disc Holder and Nut: Bronze.
- (6) Disc Seat: Nitrile.
- (7) Packing: Asbestos free.
- (8) Handwheel: Malleable iron, bronze, or aluminum.

2.2.8 Backflow Preventers

a. Reduced-Pressure-Principle Backflow Preventers:

- (1) Standard: ASSE 1013 or AWWA C511.
- (2) Operation: Continuous-pressure applications.
- (3) Pressure Loss: 12 psig maximum, through middle one-third of flow range.
- (4) Size: As required.

- (5) Body Material: Bronze for NPS 2 and smaller; cast iron, steel, or stainless steel with interior lining complying with AWWA C550 for NPS 2-1/2 and larger.
- (6) End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
- (7) Configuration: Designed for horizontal, straight through or vertical inlet, horizontal center section, and vertical outlet flow.
- (8) Accessories:
 - 1. Valves: Ball type with threaded ends on inlet and outlet of NPS 2 and smaller; OS&Y gate type with flanged ends on inlet and outlet of NPS 2-1/2 and larger.
 - 2. Air-Gap Fitting: ASME A112.1.2, matching backflow preventer connection.

b. Backflow Preventer Test Kits:

- (1) Description: Factory calibrated, with gages, fittings, hoses, and carrying case with test-procedure instructions.

2.2.9 Painting

Furnish equipment of the manufacturer's standard product with the manufacturer's standard finish coat.

Furnish other mechanical equipment with a shop-applied prime paint.

2.2.10 Equipment Labels

- a. Material and Thickness: Brass, 0.032 inch stainless steel, 0.025 inch thick, with predrilled holes for attachment hardware.
- b. Letter Color: Black.
- c. Background Color: Natural.
- d. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- e. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- f. Fasteners: Stainless-steel rivets or self-tapping screws.
- g. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.

Equipment-Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2.11 Warning Signs and Labels

- a. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, with predrilled holes for attachment hardware.
- b. Letter Color: White.
- c. Background Color: White.
- d. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- e. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- f. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- g. Fasteners: Stainless-steel rivets or self-tapping screws.
- h. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- i. Label Content: Include caution and warning information, plus emergency notification instructions.

2.2.12 Pipe Labels

- a. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service and showing flow direction according to ASME A13.1.
- b. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
- c. Self-adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- d. Pipe-Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
 - (1) Flow-Direction Arrows: Integral with piping-system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
 - (2) Lettering Size: Size letters according to ASME A13.1 for

piping. At least 1/2 inch for viewing distances up to 72 inches and proportionately larger lettering for greater viewing distances.

e. Pipe-Label Colors:

- (1) Background Color: Safety Red.
- (2) Letter Color: White

2.2.13 Stencils for Piping:

- a. Lettering Size: Size letters according to ASME A13.1 for piping. At least 1/2 inch for viewing distances up to 72 inches and proportionately larger lettering for greater viewing distances.
- b. Stencil Material: Brass.
- c. Stencil Paint: Safety Red, exterior, gloss, alkyd enamel. Paint may be in pressurized spray-can form.
- d. Identification Paint: White, exterior, alkyd enamel. Paint may be in pressurized spray-can form.

2.2.14 Valve Tags

- a. Description: Stamped or engraved with 1/4-inch letters for piping-system abbreviation and 1/2-inch numbers.
 - (1) Tag Material: Brass, 0.032 inch stainless steel, 0.025 inch thick, with predrilled holes for attachment hardware.
 - (2) Fasteners: Brass wire-link chain or S-hook.
 - (3) Valve-Tag Color: Safety Red.
 - (4) Letter Color: White.
- b. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

2.2.15 Warning Tags

- a. Description: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.
 - (1) Size: 3 by 5-1/4 inches.
 - (2) Fasteners: Brass grommet and wire.
 - (3) Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
 - (4) Color: Safety Yellow background with black lettering.

2.3 MATERIALS

2.3.1 Bituminous Coating

Bituminous coating is a solvent cutback, heavy-bodied material to produce not less than a 12-mil dry-film thickness in one coat and is as recommended by the conduit manufacturer for compatibility with factory coating and rubber joints.

For previously coal-tar-coated and for uncoated ferrous surfaces underground, ensure the bituminous coating is a solvent cutback coal-tar type, conforming to MIL-C-18480.

2.3.2 Bolting

Ensure flange and general-purpose bolting is hex-head and conforms to ASTM A307, Grade B. Ensure heavy hex-nuts conform to ASTM A563. Square-head bolts and nuts are not acceptable.

2.3.3 Elastomer Caulk

Use two component polysulfide- or polyurethane-base elastomer-caulking material, conforming to ASTM C920.

2.3.4 Escutcheons

Manufacture escutcheons from nonferrous metals. Use chrome-plated escutcheons, except when AISI 300 series corrosion-resistant steel is provided. Ensure metals and finish conform to ASME A112.18.1/CSA B125.1.

- a. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.
- b. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.
- c. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.
- d. Split-Casting Brass Type: With polished, chrome-plated finish and with concealed hinge and setscrew.
- e. Split-Plate, Stamped-Steel Type: With chrome-plated finish, concealed and exposed-rivet hinge, and spring-clip fasteners.
- f. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.
- g. Split-Casting Floor Plates: Cast brass with concealed hinge.

Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

2.3.4.1 Escutcheons for New Piping:

- a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
- b. Chrome-Plated Piping: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.

- c. Insulated Piping: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge or split-plate, stamped-steel type with exposed-rivet hinge.
- d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
- e. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge or split-plate, stamped-steel type with exposed-rivet hinge.
- f. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
- g. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge or split-plate, stamped-steel type with exposed-rivet hinge.
- h. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
- i. Bare Piping in Unfinished Service Spaces: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge or split-plate, stamped-steel type with exposed-rivet hinge.
- j. Bare Piping in Equipment Rooms: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
- k. Bare Piping in Equipment Rooms: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge or split-plate, stamped-steel type with exposed-rivet hinge.

2.3.4.2 Escutcheons for Existing Piping:

- a. Chrome-Plated Piping: Split-casting brass type with polished, chrome-plated finish.
- b. Insulated Piping: Split-plate, stamped-steel type with concealed or exposed-rivet hinge.
- c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-casting brass type with polished, chrome-plated finish.
- d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed or exposed-rivet hinge.
- e. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-casting brass type with polished, chrome-plated finish.
- f. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed or exposed-rivet hinge.
- g. Bare Piping in Unfinished Service Spaces: Split-casting brass type with polished, chrome-plated finish.
- h. Bare Piping in Unfinished Service Spaces: Split-plate, stamped-steel

type with concealed or exposed-rivet hinge.

- i. Bare Piping in Equipment Rooms: Split-casting brass type with polished, chrome-plated finish.
- j. Bare Piping in Equipment Rooms: Split-plate, stamped-steel type with concealed or exposed-rivet hinge.
- A. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
 - 1. New Piping: One-piece, floor-plate type.
 - 2. Existing Piping: Split-casting, floor-plate type.

2.3.5 Flashing

2.3.5.1 Lead

Ensure sheet lead conforms to [ASTM B749](#), and weighs not less than 4 pounds per square foot.

2.3.5.2 Copper

Ensure sheet copper conforms to [ASTM B370](#) and weighs not less than 16 ounces per square foot.

2.3.6 Flange Gaskets

Ensure gaskets are suitable for the intended use and contain no asbestos.

2.3.7 Pipe-Thread Compounds

Use tetrafluoroethylene tape or other suitable compounds.

PART 3 EXECUTION

3.1 PREPARATION

3.1.1 Painting

If manufacturer's standard-finish equipment surfaces are damaged during construction, bring to as-new condition by touchup or repainting to the satisfaction of the Contracting Officer, or replaced with new undamaged equipment at no additional cost to the Government.

Thoroughly clean and paint hangers, supports, and other iron work in concealed spaces with one coat of primer paint.

Apply two coats of enamel paint to all firex piping, valves, and appurtenances, including hose racks and reels, but excluding hoses, hose nozzles and siamese connections. Use paint color No. 11105 (red) in accordance with [MIL-STD-101](#) and [SAE AMS-STD-595A](#).

3.2 INSTALLATION

Ensure installation of system materials and equipment is in accordance with the recommendations and provisions of [NFPA 13](#), [NFPA 13E](#), [NFPA 14](#), and [NFPA 24](#). Perform work in the presence of the Contracting Officer. Notify

the Contracting Officer 48 hours in advance of the start of work.

Perform all installation work by licensed fire protection sprinkler contractors, licensed for such work in the state where the work is to be performed.

3.2.1 Underground Piping Installation

Ensure installation of piping materials conforms to the written or published instructions of the manufacturer.

For pipes passing through walls below grade and ground-floor slab, insert the pipe through pipe sleeves one size larger than pipe. Caulk the pipe sleeve watertight with lead and oakum or mechanically expandable chloroprene inserts with bitumen sealed metal components.

In fill areas, ensure the pipe passing under or through building grade beams has a minimum clearance of 4 inches in all directions.

For rubber- or elastomer-jointed piping embedded in concrete walls, install a joint within 6 inches of the face of the wall capable of absorbing movement without leakage.

Use extended-joint or flange-bolt pipe when penetrating earth or concrete grade to a height 6 inches above the grade.

Support underground piping below supported or suspended slabs from the slab with a minimum of two supports per length of pipe. Protect supports with a coating of bitumen.

On excavations near and below building footings, use the backfilling material consisting of 2,000-psi cured-strength concrete, poured or pressure-grouted up to the level of the footing.

After piping has been inspected, and not less than 48 hours prior to being lowered into a trench, coat external surfaces of the piping, valves, valve operators, and valve boxes with a compatible bituminous coating suitable for protection against brackish ground water. Apply coating in accordance with the manufacturer's instructions to a dry-film thickness of not less than 12 mils.

Water-Main Connection: Arrange with water utility department for tap of size and in location indicated in water main. Tap water main according to requirements of water utility company and of size and in location indicated.

3.2.1.1 Ductile Iron Pipe Construction Tolerances

Ensure maximum deviation from design elevation at any point along piping does not exceed 2-1/2 inches for all sizes of piping.

Maximum deviation from line at the end of an 18-foot length of piping is 2-1/2 inches and cumulatively does not exceed 6 inches. Make corrections from line within preceding tolerances at a rate not to exceed 2-1/2 inches for any one length of piping.

When the alignment requires deflections in excess of the above limitations, furnish special bends or a sufficient number of shorter lengths of pipe to provide angular deflections within established limits,

as approved.

3.2.1.2 Valve Boxes

Set valve and valve boxes plumb. Center valve boxes on the valves. Where feasible, locate valves outside traffic areas. Carefully tamp soil around each valve box to a distance of 4 feet on all sides of the box or to the undisturbed trench face when less than 4 feet.

3.2.1.3 Thrust Blocks

Construct 3,000-psi cured-strength thrust blocks to absorb hydraulic thrust at caps, plugs, and at system change-of-direction fittings. Place concrete against undisturbed soil, with an area sufficient to provide load transmittal.

3.2.1.4 Water Meter Installation

- a. Install water meters, piping, and specialties according to utility company's written instructions.
- b. Support water meters and piping NPS 3 and larger on concrete piers. Comply with requirements for concrete piers in Section 03 30 00 - Cast-in-Place Concrete.

3.2.1.5 Backflow Preventer Installation

- a. Install backflow preventers of type, size, and capacity indicated. Include valves and test cocks. Install according to requirements of plumbing and health department and authorities having jurisdiction.
- b. Do not install backflow preventers that have relief drain in vault or in other spaces subject to flooding.
- c. Do not install bypass piping around backflow preventers.
- d. Support NPS 2-1/2 and larger backflow preventers and piping on concrete piers. Comply with requirements for concrete piers in Section 03 30 00 - Cast-in-Place Concrete.

3.2.2 Aboveground Piping-Systems Installation

Run piping parallel with the lines of the building. Space and install piping and components so that a threaded pipe fitting may be removed between adjacent pipes and so that there is not less than 1/2 inch of clear space between the finished surface and other work and between the finished surface of parallel adjacent piping. Arrange hangers on different adjacent service lines running parallel to be in line with each other and parallel to the lines of the building.

Base the load rating for pipe-hanger supports on all lines filled with water. Deflection per span cannot not exceed slope gradient of pipe. Ensure Schedule 40 and heavier ferrous pipe supports are in accordance with the following minimum rod size and maximum allowable hanger spacing. For concentrated loads such as valves, reduce the allowable span proportionately.

PIPE SIZE (INCHES)	ROD SIZE (INCHES)	HANGER SPACING FOR STEEL PIPE (FEET)
Up to 1	3/8	8
1-1/4	3/8	12
1-1/2	3/8	15
2-1/2 to 3-1/2	3/8	15
5	1/2	15
6	1/2	15
8	1/2	15

Support vertical risers at the base where possible and at intervals specified. Guide piping for lateral stability as necessary. Place clamps under fittings wherever possible. Support carbon-steel pipe at each floor at not more than 15-foot intervals for pipe 2 inches and smaller, and at not more than 20-foot intervals for pipe 2-1/2 inches and larger.

Securely support pipe with allowance for thrust forces, thermal expansion and contraction, and not be subject to mechanical, chemical, vibrational, or other damage, in conformance with ASME B31.1.

3.2.3 Sound Stopping

Provide effective sound stopping and adequate operating clearance to prevent structure contact where piping penetrates walls, floors, or ceilings; into occupied spaces adjacent to equipment rooms; where similar penetrations occur between occupied spaces; and where penetrations occur from pipe chases into occupied spaces. Occupied spaces include space above ceiling where no special acoustic treatment of ceiling is provided. Construct penetrations with finishes compatible with surface being penetrated.

Sound stopping and vapor-barrier sealing of pipe shafts, and large floor and wall openings may be accomplished by packing with properly supported mineral fiber insulation or by foaming-in-place with self-extinguishing, 2-pound density polyurethane foam to a depth not less than 6 inches. Finish foam with a rasp. Ensure vapor barrier is not less than 1/8-inch thickness of vinyl mastic applied to visible and accessible surfaces. Where fire stopping is a consideration, use only mineral fiber, and, in addition, cover openings with 16-gage sheet metal.

3.2.4 Sleeves

Provide sleeves where piping passes through roofs, masonry or concrete walls, or floors.

Continuously weld or braze sleeves to the deck when passing through steel decks.

Install sleeves that are continuous when extending through floors, roofs,

or load-bearing walls, and sleeves through fire barriers. Fabricate sleeves from Schedule 40 steel pipe with welded anchor lugs. Form other sleeves by molded linear polyethylene liners or similar materials that are removable. Ensure diameter of sleeves is large enough to accommodate pipe, insulation, and jacketing without touching the sleeve, and additionally provides a minimum 3/8-inch clearance. Install sleeve to accommodate mechanical and thermal motion of pipe and to preclude transmission of vibration to walls and generation of noise.

Pack solid the space between a pipe and the inside of a pipe sleeve or a construction surface penetration or wherever the piping passes through firewalls, equipment-room walls, floors, and ceilings connected to occupied spaces, and other locations where sleeves or construction-surface penetrations occur between occupied spaces. Use a mineral fiber conforming to ASTM C592. Where sleeves or construction-surface penetrations occur between conditioned and unconditioned spaces, fill the space between a pipe, bare or insulated, and the inside of a pipe sleeve or construction-surface penetration with an elastomer caulk to a depth of 1/2 inch. Ensure surfaces are oil- and grease-free before caulking.

Caulk exterior wall sleeves watertight with lead and oakum or mechanically expandable chloroprene inserts with mastic-sealed components.

3.2.5 Escutcheons

Install escutcheons at penetrations of piping into finished areas. Where finished areas are separated by partitions through which piping passes, provide escutcheons on both sides of the partition. Where suspended ceilings are installed, attach plates at the underside only of such ceilings. Use chrome plated escutcheons in occupied spaces and conceal openings in building construction. Ensure escutcheons are firmly attached.

3.2.6 Flashings

Install flashings at systems penetrations of building boundaries as indicated.

3.2.7 Fire-Department Connection Installation

- a. Install ball drip valves at each check valve for fire-department connection to mains.
- b. Install protective pipe bollards on two sides of each freestanding fire-department connection. Pipe bollards are specified in Section 05 50 13 - Metal Fabrications.

3.2.8 Alarm Device Installation

- a. General: Comply with NFPA 24 for devices and methods of valve supervision. Underground valves with valve box do not require supervision.
- b. Supervisory Switches: Supervise valves in open position.
 - (1) Valves: Grind away portion of exposed valve stem. Bolt switch, with plunger in stem depression, to OS&Y gate-valve yoke.
 - (2) Indicator Posts: Drill and thread hole in upper-barrel section at target plate. Install switch, with toggle against target plate,

on barrel of indicator post.

- c. Locking and Sealing: Secure unsupervised valves as follows:
 - (1) Valves: Install chain and padlock on open OS&Y gate valve.
 - (2) Post Indicators: Install padlock on wrench on indicator post.
- d. Pressure Switches: Drill and thread hole in exposed barrel of fire hydrant. Install switch.
- e. Water-Flow Indicators: Install in water-service piping in vault. Select indicator with saddle and vane matching pipe size. Drill hole in pipe, insert vane, and bolt saddle to pipe.
- f. Connect alarm devices to building's fire-alarm system. Wiring and fire-alarm devices are specified in Section "Digital, Addressable Fire-Alarm System."

3.2.9 Connections

- a. Connect fire-suppression water-service piping to utility water main. Use tapping sleeve and tapping valve or service clamp and corporation valve.
- b. Connect fire-suppression water-service piping to interior fire-suppression piping.

3.2.10 Electrical Work

Electrical work is specified in DIVISION 26 ELECTRICAL except for control and fire alarm wiring which is provided under this section in accordance with **NFPA 70**. Use rigid metal conduit or intermediate metal conduit, except that electrical metallic tubing may be used in dry locations not enclosed in concrete or where not subject to mechanical damage.

Furnish motors, controllers, contactors, and disconnects with their respective pieces of equipment, except that controllers indicated as part of the motor control centers
Ensure motors, controllers, contactors, and
disconnects conform to and have electrical connections provided under

Ensure controllers and contactors have maximum 120-volt control circuits, and auxiliary contacts for use with the controls furnished.

3.3 FIELD QUALITY CONTROL

3.3.1 Fire-Protection System Identification

Create a coordinated system of piping and equipment identification which includes the following:

- a. Framed and plastic-protected diagrammatic layout of all piping systems, identifying and locating piping, equipment, and valves. Where existing systems are being modified, bring existing layouts up to date.
- b. Metal-tag-identified major valves, piping-system components, and equipment.

- c. Metal identification plate at controlling alarm valve identifying system and area protected.
- d. Service-labeled piping.
- e. Permanently attach equipment nameplate or marker indicating plastic fire-suppression water-service piping or fire-suppression water-service piping with electrically insulated fittings, on main electrical meter panel.
- f. Install continuous underground detectable warning tape during backfilling of trench for underground fire-suppression water-service piping. Locate below finished grade, directly over piping. Underground warning tapes are specified in Section "Earth Moving."

3.3.1.1 Diagrams

Chart listing of equipment is by designation number and shows pertinent data. Mount mechanical drawings in extruded aluminum frames with 1/8-inch thick acrylic plastic protection. Location is as directed by the Contracting Officer. Provide a minimum of one mounted chart and diagram, plus one extra copy of each, for each fire-protection system.

3.3.1.2 Metal Tags

Install identification tags made of brass or aluminum and indicating function of valve or similar component, on such system devices. furnish tags not less than 2 inches in diameter with a stamped marking.

Install equipment with metal identification tags that bear an equipment designation number matching the drawing or diagram designations.

Secure tags to valve or equipment items with 12-gage galvanized wire.

Tag valves according to size, shape, and with captions similar to those indicated below:

a. Valve-Tag Size and Shape:

- (1) Fire-Suppression Standpipe: 1-1/2 inches, round.
- (2) Wet-Pipe Sprinkler System: 1-1/2 inches, round.
- (3) Dry-Pipe Sprinkler System: 1-1/2 inches, round.
- (4) Clean-Agent Fire-Extinguishing System: 1-1/2 inches, round.

3.3.1.3 Stenciled Pipe-Label Option:

Stenciled labels may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels, complying with ASME A13.1, with painted, color-coded bands or rectangles on each piping system.

- a. Identification Paint: Use for contrasting background.
- b. Stencil Paint: Use for pipe marking.

3.3.1.4 Service Labeling

Label piping, including that concealed in accessible spaces, to designate service. Include on each label, an arrow or arrows to indicate flow direction. Labels or tag designations are as follows:

SERVICE	LABEL OR TAG DESIGNATION
Main sprinkler supply	MAIN SPRINKLER SUPPLY
Sprinkler riser number	SPRINKLER RISER NO.
Sprinkler branch	SPRINKLER BRANCH
Standpipe piping	STANDPIPE

Label piping and arrow in accordance with the following:

- Each point of entry and exit through walls.
- Each change in direction.
- In congested or hidden areas, at each point required to clarify service or indicate hazard.
- In long straight runs, locate labels at a distance visible to each other, but in no case have the distance between labels exceed 40 feet.
- Ensure lettering is 2 inches high. Where the size of pipes is 2-1/2-inch outside diameter and smaller, attach labels to 16-gage aluminum sheet and attach to the pipe with 12-gage galvanized wire. Ensure labels are legible from the primary service and operating area.
- Make labels of self-sticking plastic film designed for permanent installation. Provide labels with red letters on white background.
- The label and valve tag schedule above is not construed as defining or limiting the work. Label all piping.

3.3.2 Branch-Line Testers

Ensure branch-line testers permit testing and flushing lines without shutdown of system or loss of fire-protection capability. Fit line testers with chain-attached caps.

Install line testers where indicated and on most remote branch lines being served by cross mains, so that testing may be accomplished at the dead corners of each sprinkler system.

3.3.3 System Testing

Government will supply testing water at a location determined by the Contracting Officer. The Contractor is responsible for approved disposal of contaminated water.

Prior to acceptance of the work, test completed systems in the presence of the Contracting Officer. Upon approval, provide certificates of testing.

Conduct a hydrostatic test, unless otherwise specified. Use only potable water for testing.

Perform [air tests](#), [valve-operating tests](#), and [drainage tests](#) for dry-pipe systems.

Perform full-flow [system operating tests](#) for standpipe systems.

Prepare and maintain test records of piping-system tests. Ensure records show personnel responsibilities, dates, test-gage identification numbers, ambient and test-water temperatures, pressure ranges, rates of pressure drops, and leakage rates. Each test acceptance requires the signature of the Contracting Officer.

3.3.4 Test Gages

Acceptable test gages have [4-1/2-inch](#) dials or larger with accuracy of plus or minus 1/2 of 1 percent of full-scale range and dial graduations and pointer width compatible with readability to within one-half of the accuracy extremes. Maximum permissible scale range for a given test is such that the pointer during a test has a starting position at midpoint of the dial or within the middle third of the scale range. Ensure the Certification of accuracy and correction table has: a date within 90 calendar days prior to the test, the test gage number, and the project number.

3.3.5 Pneumatic Testing

Perform pneumatic Pressure Tests when freezing conditions may occur and upon prior approval by the Contracting Officer. Use oil-free compressed air used for testing. Pneumatic testing includes swabbing all joints under a test pressure of [5 psig](#) with a standard high film strength soap solution and observing for bubbles.

Duration of the test will be determined by the Contracting Officer and will be for 2 hours, minimum, to 24 hours, maximum. Test may be terminated by direction of the Contracting Officer at any point during this period after it has been determined that the permissible leakage rate has not been exceeded.

3.3.6 Test and Acceptable Criteria

Perform above ground systems [pressure tests](#) at [200 psi](#) and maintain the applied pressure without further addition of test media for not less than 2 hours. No pressure drop is allowed.

Test underground rubber-jointed ferrous-pipe water systems at [200 psi](#), and maintain the applied test pressure for not less than 2 hours. Maximum allowable pressure drop is [2 psi](#). After satisfactory hydrostatic testing, test piping for leakage as follows:

- a. Duration of each leakage test is not less than 2 hours; during the test, subject the main to [200 psi](#) pressure based on the elevation of the lowest section under test and corrected to the elevation of the test gage.
- b. Leakage is defined as the quantity of water supplied into the laid pipe, or any valved section thereof, necessary to maintain the

specified leakage test pressure after the pipe has been filled with water and the air expelled.

- c. No piping installation will be accepted if the leakage in gallons per hour exceeds 0.00054 times the number of joints in the length of the pipe line tested times the nominal diameter of the pipe in inches times the square root of the average test pressure expressed as psig. Amount of leakage at the joints cannot exceed 2 quarts per 100 joints regardless of pipe diameter.
- d. Apply hydrostatic tests to piping with concrete thrust blocking only after the concrete has cured for more than 7 calendar days.

Test backflow prevention into connected potable-water systems and system devices for proper functioning under conditions normal to their application.

Repair dripping or weeping joints.

3.4 ADJUSTING AND CLEANING

At the completion of the work, clean all parts of the installation. Clean equipment, pipes, valves, and fittings of grease, metal cuttings, and sludge that may have accumulated from the installation and testing of the system. Adjust automatic control devices for proper operation.

3.5 PROTECTION

3.5.1 Disinfection

Disinfect water piping, including valves, fittings, and other devices, with a solution of chlorine and water. Use a solution containing not less than 50 parts per million (ppm) of available chlorine. Hold solution for a period of not less than 8 hours, at which time the solution contains a minimum residue of 2 ppm of available chlorine or repeat disinfection of the system. After successful disinfection the piping, thoroughly flush the system before placing into service. Water for both disinfection and flushing will be furnished by the Government.

3.6 PIPING SCHEDULE

- a. Piping materials subject to local utility company requirements.
- b. Underground fire-suppression water-service piping NPS 6 to NPS 12 shall be one of the following:
 - (1) Grooved-end, ductile-iron pipe; grooved-end, ductile-iron pipe appurtenances; and grooved joints.
 - (2) Mechanical-joint, ductile-iron pipe; mechanical-joint, ductile- or gray-iron, standard-pattern or ductile-iron, compact-pattern fittings; glands, gaskets, and bolts; and gasketed joints.
 - (3) Push-on-joint, ductile-iron pipe; push-on-joint, ductile-iron compact-pattern fittings; and gasketed joints.
 - (4) PE, Class 150 or Class 200, fire-service pipe; molded PE fittings; and heat-fusion joints.

- (5) PVC, Class 150 or Class 200 pipe listed for fire-protection service; PVC fittings of same class as pipe; and gasketed joints.
- c. Aboveground and vault fire-suppression water-service piping NPS 4 shall be the following:
 - (1) Grooved-end, ductile-iron pipe; grooved-end, ductile-iron pipe appurtenances; and grooved joints.
- d. Aboveground and vault fire-suppression water-service piping NPS 5 to NPS 12 shall be grooved-end, ductile-iron pipe; grooved-end, ductile-iron pipe appurtenances; and grooved joints.
- e. Underslab fire-suppression water-service piping NPS 4 shall be one of the following:
 - (1) Grooved-end, ductile-iron pipe; grooved-end, ductile-iron pipe appurtenances; and grooved joints.
 - (2) Mechanical-joint, ductile-iron pipe; mechanical-joint, ductile- or gray-iron, standard-pattern or ductile-iron, compact-pattern fittings; glands, gaskets, and bolts; and restrained, gasketed joints.
 - (3) Push-on-joint, ductile-iron pipe; push-on-joint, ductile-iron compact-pattern fittings; and restrained, gasketed joints.
- f. Underslab fire-suppression water-service piping NPS 6 to NPS 12 shall be one of the following:
 - (1) Grooved-end, ductile-iron pipe; grooved-end, ductile-iron pipe appurtenances; and grooved joints.
 - (2) Mechanical-joint, ductile-iron pipe; mechanical-joint, ductile- or gray-iron, standard-pattern or ductile-iron, compact-pattern fittings; glands, gaskets, and bolts; and restrained, gasketed joints.
 - (3) Push-on-joint, ductile-iron pipe; push-on-joint, ductile-iron compact-pattern fittings; and restrained, gasketed joints.

3.7 VALVE SCHEDULE

- a. Underground fire-suppression water-service shutoff valves NPS 4 and larger shall be one of the following:
 - (1) 200-psig, AWWA, iron, nonrising-stem, metal or resilient-seated gate valves.
 - (2) 250-psig, AWWA, iron, nonrising-stem, resilient-seated gate valves.
 - (3) 175-psig, UL-listed or FM Global-approved, iron, nonrising-stem gate valves.
- b. Indicator-post underground fire-suppression water-service valves NPS 4 and larger shall be 175-psig, UL-listed or FM Global-approved, iron, nonrising-stem gate valves with indicator-post flange.

- c. Standard-pressure, aboveground and vault fire-suppression water-service shutoff valves NPS 4 and larger shall be one of the following:
 - (1) 200-psig, AWWA, iron, OS&Y, metal or resilient-seated gate valves.
 - (2) 250-psig, AWWA, iron, OS&Y, resilient-seated gate valves.
 - (3) 175-psig, UL-listed or FM Global-approved, iron, OS&Y gate valves.
 - (4) AWWA or UL-listed or FM Global-approved butterfly valves.
 - d. Fire-suppression water-service check valves NPS 4 and larger shall be one of the following:
 - (1) AWWA or UL-listed or FM Global-approved check valves.
 - (2) UL-listed or FM Global-approved detector check valves.
- End of Section --

SECTION 21 13 13

WET PIPE SPRINKLER SYSTEMS, FIRE PROTECTION
08/20

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.4 (2021) Gray Iron Threaded Fittings;
Classes 125 and 250

AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)

ASSE 1013 (2021) Performance Requirements for
Reduced Pressure Principle Backflow
Prevention Assemblies

ASSE 1015 (2021) Performance Requirements for Double
Check Backflow Prevention Assemblies

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C203 (2020) Coal-Tar Protective Coatings and
Linings for Steel Water Pipelines - Enamel
and Tape - Hot-Applied

AWWA M14 (2015) Manual: Recommended Practice for
Backflow Prevention and Cross-Connection
Control

AMERICAN WELDING SOCIETY (AWS)

AWS D10.12M/D10.12 (2000) Guideline for Welding Mild Steel
Pipe

ASTM INTERNATIONAL (ASTM)

ASTM A53/A53M (2022) Standard Specification for Pipe,
Steel, Black and Hot-Dipped, Zinc-Coated,
Welded and Seamless

ASTM A135/A135M (2021) Standard Specification for
Electric-Resistance-Welded Steel Pipe

ASTM A536 (1984; R 2019; E 2019) Standard
Specification for Ductile Iron Castings

FM GLOBAL (FM)

FM APP GUIDE Approval Guide
<http://www.approvalguide.com/>

INTELLIGENCE COMMUNITY STANDARD (ICS)

ICS 705-1 (2010) Physical and Technical Security
Standard for Sensitive Compartmented
Information Facilities

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS
INDUSTRY (MSS)

MSS SP-71 (2018) Gray Iron Swing Check Valves,
Flanged and Threaded Ends

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 13 (2022; ERTA 3 2022) Standard for the
Installation of Sprinkler Systems

NFPA 13R (2022) Standard for the Installation of
Sprinkler Systems in Low-Rise Residential
Occupancies

NFPA 24 (2022) Standard for the Installation of
Private Fire Service Mains and Their
Appurtenances

NFPA 101 (2021; TIA 21-1) Life Safety Code

NFPA 291 (2022) Recommended Practice for Fire Flow
Testing and Marking of Hydrants

NFPA 1963 (2019) Standard for Fire Hose Connections

NATIONAL INSTITUTE FOR CERTIFICATION IN ENGINEERING TECHNOLOGIES
(NICET)

NICET 1014-7 (2012) Program Detail Manual for
Certification in the Field of Fire
Protection Engineering Technology (Field
Code 003) Subfield of Automatic Sprinkler
System Layout

UNDERWRITERS LABORATORIES (UL)

UL 199 (2020) UL Standard for Safety Automatic
Sprinklers for Fire-Protection Service

UL 312 (2022) UL Standard for Safety Check Valves
for Fire-Protection Service

UL 405 (2013; Bul. 2020) UL Standard for Safety
Fire Department Connection Devices

UL 1767 (3013; Bul. 2015) UL Standard for Safety
Early-Suppression Fast-Response Sprinklers

UL Fire Prot Dir (2012) Fire Protection Equipment Directory

1.2 SYSTEM DESCRIPTION

Provide wet pipe sprinkler system(s) in areas indicated on the drawings. Except as modified herein, the system must meet the requirements of NFPA 13. Pipe sizes which are not indicated on the Contract drawings must be determined by hydraulic calculations.

1.2.1 Delegated Design:

Engage a qualified professional engineer, as defined in Section "Quality Requirements," to design wet-pipe sprinkler systems.

Sprinkler system design shall be approved by authorities having jurisdiction.

a. Margin of Safety for Available Water Flow and Pressure: 10 percent, including losses through water-service piping, valves, and backflow preventers.

B. Sprinkler Occupancy Hazard Classifications as defined by NFPA 13:

- (1) Automobile Parking Areas: Ordinary Hazard, Group 1.
- (2) Building Service Areas: Ordinary Hazard, Group 1.
- (3) Electrical Equipment Rooms: Ordinary Hazard, Group 1.
- (4) General Storage Areas: Ordinary Hazard, Group 1.
- (5) Laundries: Ordinary Hazard, Group 1.
- (6) Libraries except Stack Areas: Light Hazard.
- (7) Machine Shops: Ordinary Hazard, Group 2.
- (8) Mechanical Equipment Rooms: Ordinary Hazard, Group 1.
- (9) Office and Public Areas: Light Hazard.
- (10) Restaurant Service Areas: Ordinary Hazard, Group 1.

c. Minimum Density for Automatic-Sprinkler Piping Design:

- (1) Light-Hazard Occupancy: 0.10 gpm over 1500-sq. ft. area.
- (2) Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm over 1500-sq. ft. area.
- (3) Ordinary-Hazard, Group 2 Occupancy: 0.20 gpm over 1500-sq. ft. area.
- (4) Special Occupancy Hazard: As determined by authorities having jurisdiction.

d. Minimum Density for Deluge-Sprinkler Piping Design:

- (1) Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm over entire area.
- (2) Ordinary-Hazard, Group 2 Occupancy: 0.20 gpm over entire area.

(3) Special Occupancy Hazard: As determined by authorities having jurisdiction.

e. Maximum Protection Area per Sprinkler: According to UL listing.

f. Maximum Protection Area per Sprinkler:

(1) Office Spaces: 120 sq. ft.

(2) Storage Areas: 130 sq. ft.

(3) Mechanical Equipment Rooms: 130 sq. ft.

(4) Electrical Equipment Rooms: 130 sq. ft.

(5) Other Areas: According to NFPA 13 recommendations unless otherwise indicated.

1.2.2 Hydraulic Design

1.2.2.1 Basis for Calculations

Perform a fire hydrant flow test prior to shop drawing submittal in accordance with NFPA 291. Results must include hydrant elevations relative to the building and hydrant number/identifiers for the tested hydrants, including which were flowed, which had a gauge. This information must be presented in a tabular form if multiple hydrants were flowed. The results must be included with the hydraulic calculations. Hydraulic calculations must be based on flow test noted in this paragraph, unless approved by Contracting Officer. Hydraulic calculations must be based upon the Hazen-Williams formula with a "C" value noted in NFPA 13 for piping. The standard-pressure piping system component is listed for 175-psig minimum working pressure.

1.2.2.2 Hydraulic Calculations

- a. Water supply curves and system requirements must be plotted on semi-logarithmic graph ($N^{1.85}$) paper so as to present a summary of the complete hydraulic calculation.
- b. Provide a summary sheet listing sprinklers in the design area and their respective hydraulic reference points, elevations, minimum discharge pressures and minimum flows. Elevations of hydraulic reference points (nodes) must be indicated.
- c. Documentation must identify each pipe individually and the nodes connected thereto. Indicate the diameter, length, flow, velocity, friction loss, number and type fittings, total friction loss in the pipe, equivalent pipe length and Hazen-Williams coefficient for each pipe.
- d. Where the sprinkler system is supplied by interconnected risers, the sprinkler system must be hydraulically calculated using the hydraulically most demanding single riser. The calculations must not assume the simultaneous use of more than one riser.
- e. All calculations must include the backflow preventer manufacturer's stated friction loss at the design flow or 12 psi for reduced pressure

or 8 psi for double check backflow preventer, whichever is greater.

- f. All calculations must be performed back to the actual location of the flow test, taking into account the direction of flow in the service main at the test location.
- g. For gridded systems, calculations must show peaking of demand area friction loss to verify that the hydraulically most demanding area is being used. A flow diagram indicating the quantity and direction of flows must be included.

1.2.2.3 Design Criteria

Hydraulically design the system to discharge a minimum density as indicated on the drawings. Hydraulic calculations must be in accordance with the Area/Density Method of NFPA 13.

1.2.3 Sprinkler Coverage

Sprinklers must be uniformly spaced on branch lines. Provide coverage throughout 100 percent of the building. This includes, but is not limited to, telephone rooms, electrical equipment rooms (regardless of the fire resistance rating of the enclosure), boiler rooms, switchgear rooms, transformer rooms, attached electrical vaults and other electrical and mechanical spaces. Coverage per sprinkler must be in accordance with NFPA 13. Provide sprinklers below all obstructions in accordance with NFPA 13. Exceptions are as follows:

- a. Sprinklers may be omitted from small rooms which are exempted for specific occupancies in accordance with NFPA 101.
- b. Facilities that are designed in accordance with NFPA 13R.

1.2.4 Qualified Fire Protection Engineer (QFPE)

An individual who is a licensed professional engineer (P.E.) who has passed the fire protection engineering written examination administered by the National Council of Examiners for Engineering and Surveying (NCEES) and has relevant fire protection engineering experience. Services of the QFPE must include:

- a. Reviewing SD-02, SD-03, and SD-05 submittal packages for completeness and compliance with the provisions of this specification. Working (shop) drawings and calculations must be prepared by, or prepared under the immediate supervision of, the QFPE. The QFPE must affix their professional engineering stamp with signature to the shop drawings, calculations, and material data sheets, indicating approval prior to submitting the shop drawings to the DFPE.
- b. Provide a letter documenting that the SD-02, SD-03, and SD-05 submittal package has been reviewed and noting all outstanding comments.
- c. Performing in-progress construction surveillance prior to installation of ceilings (rough-in inspection).
- d. Witnessing pre-Government and final Government functional performance testing and performing a final installation review.

- e. Signing applicable certificates under SD-07.

1.3 SUBMITTALS

Government approval is required for submittals . Partial submittals and submittals not fully complying with **NFPA 13** and this specification section must be returned disapproved without review. SD-02, SD-03 and SD-05 must be submitted simultaneously.

Shop drawings (SD-02), product data (SD-03) and calculations (SD-05) must be prepared by the designer and combined and submitted as one complete package. The QFPE must review the SD-02/SD-03/SD-05 submittal package for completeness and compliance with the Contract provisions prior to submission to the Government. The QFPE must provide a Letter of Confirmation that they have reviewed the submittal package for compliance with the contract provisions. This letter must include their professional engineer stamp and signature. Partial submittals and submittals not reviewed by the QFPE must be returned disapproved without review.

Submit the following in accordance with Section **01 33 00** SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Qualified Fire Protection Engineer (QFPE)

Sprinkler System Designer

Sprinkler System Installer

SD-02 Shop Drawings

Shop Drawing

Seismic Bracing

SD-03 Product Data

Pipe

Fittings

Valves, including gate, check, butterfly, and globe

Relief Valves

Sprinklers

Pipe Hangers and Supports

Sprinkler Alarm Switch

Valve Supervisory (Tamper) Switch

Fire Department Connection

Backflow Prevention Assembly

Air Vent

Hose Valve

Nameplates

Electrically Operated Alarm Bell

Pressure Switches

Alarm Initiating And Supervisory Devices

SD-05 Design Data

Hydraulic Calculations

SD-06 Test Reports

Test Procedures

SD-07 Certificates

Verification of Compliant Installation

Request for Government Final Test

SD-10 Operation and Maintenance Data

Operating and Maintenance (O&M) Instructions

Spare Parts Data

SD-11 Closeout Submittals

As-built drawings

1.4 QUALITY ASSURANCE

1.4.1 Preconstruction Submittals

Within 36 days of contract award but no less than 14 days prior to commencing work on site, the prime Contractor must submit the following for review and approval. SD-02, SD-03 and SD-05 submittals received prior to the review and approval of the qualifications will be returned Disapproved Without Review.

1.4.1.1 Shop Drawing

6 copies of the shop drawings, no later than 28 days prior to the start of system installation. Working drawings conforming to the requirements prescribed in NFPA 13 and must be no smaller than the Contract Drawings. Each set of drawings must include the following:

- a. A descriptive index with drawings listed in sequence by number. A legend sheet identifying device symbols, nomenclature, and conventions used in the package.
- b. Floor plans drawn to a scale not less than 1/8-inch equals 1-foot clearly showing locations of devices, equipment, risers, and other details required to clearly describe the proposed arrangement.

- c. Actual center-to-center dimensions between sprinklers on branch lines and between branch lines; from end sprinklers to adjacent walls; from walls to branch lines; from sprinkler feed mains, cross mains and branch lines to finished floor and roof or ceiling. A detail must show the dimension from the sprinkler and sprinkler deflector to the ceiling in finished areas.
- d. Sprinkler systems drawings shall indicate coordination with the following systems:
 - 1. Plumbing systems: Domestic water piping, gas piping, storm piping and sanitary piping.
 - 2. HVAC hydronic piping, ductwork, and equipment.
- e. Items penetrating finished ceiling include the following:
 - 1. Lighting fixtures.
 - 2. Air outlets and inlets.
- f. Longitudinal and transverse building sections showing typical branch line and cross main pipe routing, elevation of each typical sprinkler above finished floor and elevation of "cloud" or false ceilings in relation to the building ceilings.
- g. Plan and elevation views which establish that the equipment will fit the allotted spaces with clearance for installation and maintenance.
- h. Riser layout drawings drawn to a scale of not less than $\frac{1}{2}$ -inch equals 1-foot to show details of each system component, clearances between each other and from other equipment and construction in the room.
- i. Details of each type of riser assembly, pipe hanger, and restraint of underground water main at point-of-entry into the building, and electrical devices and interconnecting wiring. The dimension from the edge of vertical piping to the nearest adjacent wall(s) must be indicated on the drawings when vertical piping is located in stairs or other portions of the means of egress.
- j. Details of each type of pipe hanger, restraint, and related components.

1.4.1.2 Product Data

6 copies of annotated catalog data to show the specific model, type, and size of each item. Catalog cuts must also indicate the NRTL listing. The data must be highlighted to show model, size, options, and other pertinent information, that are intended for consideration. Data must be adequate to demonstrate compliance with all contract requirements. Product data for all equipment must be combined into a single submittal.

1.4.1.3 Hydraulic Calculations

Calculations must be as outlined in NFPA 13 except that calculations must be performed by computer using software intended specifically for fire protection system design using the design data shown on the drawings. Calculations must include isometric diagram indicating hydraulic nodes and

pipe segments.

1.4.1.4 Operating and Maintenance (O&M) Instructions

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA as supplemented and modified by this specification section.

Provide six manuals and one pdf version on electronic media. The manuals must include the manufacturer's name, model number, parts list, list of parts and tools that should be kept in stock by the owner for routine maintenance, troubleshooting guide, and recommended service organization (including address and telephone number) for each item of equipment. Each service organization submitted must be capable of providing 4-hour on-site response to a service call on an emergency basis.

Submit spare parts data for each different item of material and equipment specified. The data must include a complete list of parts and supplies, and a list of parts recommended by the manufacturer to be replaced after 1-year and 3 years of service. Include a list of special tools and test equipment required for maintenance and testing of the products supplied.

1.4.2 Qualifications

1.4.2.1 Sprinkler System Designer

The sprinkler system designer must be certified as a Level [III][IV] Technician by National Institute for Certification in Engineering Technologies (NICET) in the Water-Based Systems Layout subfield of Fire Protection Engineering Technology in accordance with NICET 1014-7.

1.4.2.2 Sprinkler System Installer

The sprinkler system installer must be regularly engaged in the installation of the type and complexity of system specified in the contract documents, and must have served in a similar capacity for at least three systems that have performed in the manner intended for a period of not less than 6 months.

1.4.3 Regulatory Requirements

Equipment and material must be listed or approved. Listed or approved, as used in this Section, means listed, labeled or approved by a Nationally Recognized Testing Laboratory (NRTL) such as UL Fire Prot Dir or FM APP GUIDE. The omission of these terms under the description of an item or equipment described must not be construed as waiving this requirement. All listings or approvals by testing laboratories must be from an existing ANSI or UL published standard. The recommended practices stated in the manufacturer's literature or documentation are mandatory requirements.

1.5 DELIVERY, STORAGE, AND HANDLING

Protect all equipment delivered and placed in storage from the weather, excessive humidity and temperature variations, dirt and dust, or other contaminants. All pipes must be either capped or plugged until installed.

1.6 EXTRA MATERIALS

Spare sprinklers and wrench(es) must be provided as spare parts in

accordance with NFPA 13. Extra materials furnished must match products installed and are packaged with protective covering for storage and identified with labels describing contents.

Provide a sprinkler cabinet at a location as indicated; finished, wall-mounted, steel cabinet with hinged cover, and with space for minimum of six spare sprinklers plus sprinkler wrench. Include number of sprinklers required by NFPA 13 and sprinkler wrench. Include separate cabinet with sprinklers and wrench for each type of sprinkler used on Project.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

2.1.1 Standard Products

Provide materials, equipment, and devices listed for fire protection service when so required by NFPA 13 or this specification. Select material from one manufacturer, where possible, and not a combination of manufacturers, for a classification of material. Material and equipment must be standard products of a manufacturer regularly engaged in the manufacture of the products for at least 2 years prior to bid.

2.1.2 Nameplates

Major components of equipment must have the manufacturer's name, address, type or style, model or serial number, catalog number, date of installation, installing Contractor's name and address, and the contract number provided on a new name plate permanently affixed to the item or equipment. Nameplates must be etched metal or plastic, permanently attached by screws to control units, panels or adjacent walls.

2.1.3 Identification and Marking

Pipe and fitting markings must include name or identifying symbol of manufacturer and nominal size. Pipe must be marked with ASTM designation. Valves and equipment markings must have name or identifying symbol of manufacturer, specific model number, nominal size, name of device, arrow indicating direction of flow, and position of installation (horizontal or vertical), except if valve can be installed in either position. Markings must be included on the body casting or on an etched or stamped metal nameplate permanently on the valve or cover plate.

2.1.4 Pressure Ratings

Valves, fittings, couplings, alarm switches, and similar devices must be rated for the maximum working pressures that can be experienced in the system, but in no case less than 175 psi.

2.2 STEEL PIPE AND FITTINGS

All materials are subject to authority having jurisdiction approval.

2.2.1 Standard-Weight, Galvanized- and Black-Steel Pipe:

ASTM A53/A53M, Type E, Grade B. Pipe ends may be factory or field formed to match joining method.

2.2.2 Schedule 30, Galvanized- and Black-Steel Pipe:

ASTM A135/A135M; ASTM A 795/A 795M, Type E; or ASME B36.10M wrought steel, with wall thickness not less than Schedule 30 and not more than Schedule 40. Pipe ends may be factory or field formed to match joining method.

2.2.3 Thinwall Galvanized- and Black- Steel Pipe:

ASTM A135/A135M or ASTM A795/A795M, threadable, with wall thickness less than Schedule 30 and equal to or greater than Schedule 10. Pipe ends may be factory or field formed to match joining method.

2.2.4 Schedule 10, Black-Steel Pipe:

ASTM A135/A135M or ASTM A795/A795M, Schedule 10 in NPS 5 and smaller; and NFPA 13-specified wall thickness in NPS 6 to NPS 10, plain end.

2.2.5 Nonstandard OD, Thinwall Black-Steel Pipe:

ASTM A135/A135M or ASTM A795/A795M thinwall with plain ends and wall thickness less than Schedule 10.

2.2.6 Hybrid Black-Steel Pipe:

ASTM A135/A135M or ASTM A795/A795M lightwall, with wall thickness less than Schedule 10 and greater than Schedule 5.

2.2.7 Schedule 5 Steel Pipe:

ASTM A135/A135M or ASTM A795/A795M lightwall with plain ends.

2.2.8 Galvanized- and Black-Steel Pipe Nipples:

ASTM A733, made of ASTM A53/A53M, standard-weight, seamless steel pipe with threaded ends.

2.2.9 Galvanized- and Uncoated-Steel Couplings:

ASTM A865/A865M, threaded.

2.2.10 Galvanized and Uncoated, Gray-Iron Threaded Fittings

ASME B16.4, Class 125, standard pattern.

2.2.11 Malleable- or Ductile-Iron Unions:

UL 860.

2.2.12 Steel Welding Fittings:

ASTM A234/A234M and ASME B16.9.

- a. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.2.13 Grooved-Joint, Steel-Pipe Appurtenances:

- a. Pressure Rating: 175-psig minimum.

- b. Galvanized Uncoated Grooved-End Fittings for Steel Piping: ASTM A47/A 47M, malleable-iron casting or ASTM A536, ductile-iron casting, with dimensions matching steel pipe.
- c. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213 rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gasket, and bolts and nuts.

2.2.14 Steel Pressure-Seal Fittings:

UL 213, FM Global-approved, 175-psig pressure rating with steel housing, rubber O-rings, and pipe stop; for use with fitting manufacturers' pressure-seal tools.

2.2.15 Pipe Hangers and Supports

Provide galvanized pipe hangers, supports and seismic bracing in accordance with NFPA 13.

2.2.16 Valves

Provide valves of types approved for fire service. Valves must open by counterclockwise rotation.

2.2.16.1 Control Valve

Manually operated sprinkler control/gate valve must be outside stem and yoke (OS&Y) type and must be listed.

2.2.16.2 Check Valves

Check valves must comply with UL 312. Check valves 4 inches and larger must be of the swing type, have a clear waterway and meet the requirements of MSS SP-71, for Type 3 or 4. Inspection plate must be provided on valves larger than 6 inches.

2.3 ALARM INITIATING AND SUPERVISORY DEVICES

Alarm-device types shall match piping and equipment connections.

2.3.1 Electrically Operated Alarm Bell:

- a. Standard: UL 464.
- b. Type: Vibrating, metal alarm bell.
- c. Size: 8-inch minimum diameter.
- d. Finish: Red-enamel factory finish, suitable for outdoor use.
- e. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.3.2 Sprinkler Alarm Switch

Vane or pressure-type flow switch(es). Vane type alarm actuating devices

must have mechanical diaphragm controlled retard device adjustable from 10 to 60 seconds and must instantly recycle.

- a. Standard: UL 346.
- b. Water-Flow Detector: Electrically supervised.
- c. Components: Two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.
- d. Type: Paddle operated.
- e. Pressure Rating: 250 psig.
- f. Design Installation: Horizontal or vertical.

2.3.3 Pressure Switches:

- a. Standard: UL 346.
- b. Type: Electrically supervised water-flow switch with retard feature.
- c. Components: Single-pole, double-throw switch with normally closed contacts.
- d. Design Operation: Rising pressure signals water flow.

2.3.4 Valve Supervisory (Tamper) Switch

Switch must be integral to the control valve or suitable for mounting to the type of control valve to be supervised open. The switch must be tamper resistant and contain SPDT (Form C) contacts arranged to transfer upon removal of the housing cover or closure of the valve of more than two rotations of the valve stem.

- a. Standard: UL 346.
- b. Type: Electrically supervised.
- c. Components: Single-pole, double-throw switch with normally closed contacts.
- d. Design: Signals that controlled valve is in other than fully open position.
- e. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.4 BACKFLOW PREVENTION ASSEMBLY

Reduced-pressure principle valve assembly backflow preventer complying with ASSE 1013, ASSE 1015 and AWWA M14. Each check valve must have a drain. Backflow prevention assemblies must have current "Certificate of Approval from the Foundation for Cross-Connection Control and Hydraulic Research, FCCCHR List" and be listed for fire protection use. Listing of

the specific make, model, design, and size in the FCCCHR List is acceptable as the required documentation.

2.4.1 Backflow Preventer Test Connection

Test connection must consist of a series of listed hose valves with 2 1/2-inch National Standard male hose threads with cap and chain.

2.5 FIRE DEPARTMENT CONNECTION

Fire department connection must be flush type with cast-brass body, matching wall escutcheon lettered "Auto Spkr & Standpipe" with a chromium-plated finish. The connection must have individual self-closing clappers, caps with drip drains and chains. Female inlets must have threads according to NFPA 1963 and matching local fire-department sizes and threads. Include extension pipe nipples, brass lugged swivel connections, and check devices or clappers. Comply with UL 405.

2.6 SPRINKLERS

Sprinklers must comply with UL 199 and NFPA 13. Sprinklers with internal O-rings are not acceptable. Sprinklers in high heat areas including attic spaces or in close proximity to unit heaters must have temperature classification in accordance with NFPA 13. Extended coverage sprinklers are permitted for loading docks, residential occupancies and high-piled storage applications only. Flexible sprinkler heads are not permitted.

- a. Pressure Rating for Automatic Sprinklers: 175-psig minimum.
- b. Automatic Sprinklers with Heat-Responsive Element:
 - (1) Early-Suppression, Fast-Response Applications: UL 1767.
 - (2) Characteristics: Nominal 1/2-inch orifice with Discharge Coefficient K of 5.6, and for "Ordinary" temperature classification rating unless otherwise indicated or required by application.
- c. Open Sprinklers with Heat-Responsive Element Removed: UL 199.
 - (1) Nominal Orifice: 1/2 inch, with discharge coefficient K between 5.3 and 5.8.
 - (2) Nominal Orifice: 17/32 inch with discharge coefficient K between 7.4 and 8.2.
- d. Sprinkler Finishes: Chrome plated, bronze, and painted.
- e. Special Coatings: Wax, lead, and corrosion-resistant paint.
- f. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.
 - (1) Ceiling Mounting: Chrome-plated steel or painted, one piece, flat.
 - (2) Sidewall Mounting: Chrome-plated steel or painted, one piece, flat.

2.7 ACCESSORIES

2.7.1 Sprinkler Cabinet

Provide spare sprinklers in accordance with NFPA 13 and must be placed in a suitable metal or plastic cabinet of sufficient size to accommodate all the spare sprinklers and wrenches in designated locations. Spare sprinklers must be representative of, and in proportion to, the number of each type and temperature rating of the sprinklers installed as required by NFPA 13. At least one wrench of each type required must be provided.

2.7.2 Sprinkler Piping Specialties

2.7.2.1 Branch Outlet Fittings:

- a. Standard: UL 213.
- b. Pressure Rating: 175-psig minimum.
- c. Body Material: Ductile-iron housing with EPDM seals and bolts and nuts.
- d. Type: Mechanical-tee and -cross fittings.
- e. Configurations: Snap-on and strapless, ductile-iron housing with branch outlets.
- f. Size: Of dimension to fit onto sprinkler main and with outlet connections as required to match connected branch piping.
- g. Branch Outlets: Grooved, plain-end pipe, or threaded.

2.7.2.2 Flow Detection and Test Assemblies:

- a. Standard: UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."
- b. Pressure Rating: 175-psig minimum.
- c. Body Material: Cast- or ductile-iron housing with orifice, sight glass, and integral test valve.
- d. Size: Same as connected piping.
- e. Inlet and Outlet: Threaded or grooved.

2.7.2.3 Branch Line Testers:

- a. Standard: UL 199.
- b. Pressure Rating: 175 psig.
- c. Body Material: Brass.
- d. Size: Same as connected piping.
- e. Inlet: Threaded.

- f. Drain Outlet: Threaded and capped.
- g. Branch Outlet: Threaded, for sprinkler.

2.7.2.4 Sprinkler Inspector's Test Fittings:

- a. Standard: UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."
- b. Pressure Rating: 175-psig minimum.
- c. Body Material: Cast- or ductile-iron housing with sight glass.
- d. Size: Same as connected piping.
- e. Inlet and Outlet: Threaded.

2.7.2.5 Adjustable Drop Nipples:

- a. Standard: UL 1474.
- b. Pressure Rating: 250-psig minimum.
- c. Body Material: Steel pipe with EPDM-rubber O-ring seals.
- d. Size: Same as connected piping.
- e. Length: Adjustable.
- f. Inlet and Outlet: Threaded.

2.7.3 Pressure Gages

- a. Standard: UL 393.
- b. Dial Size: 3-1/2- to 4-1/2-inch diameter.
- c. Pressure Gage Range: 0- to 250-psig minimum.
- . Label: Include "WATER" label on dial face.

2.7.4 Relief Valve

Relief valves must be listed and installed at the riser in accordance with NFPA 13.

2.7.5 Air Vent

Air vents must be of the automatic type and piped to drain to the building exterior.

2.7.6 Identification Sign

Valve identification sign must be minimum 6 inches wide by 2 inches high with enamel baked finish on minimum 18 gage steel or 0.024-inch aluminum with red letters on a white background or white letters on red background. Wording of sign must include, but not be limited to "main drain", "auxiliary drain", "inspector's test", "alarm test", "alarm line", and similar wording as required to identify operational components. Where

there is more than one sprinkler system, signage must include specific details as to the respective system.

PART 3 EXECUTION

3.1 VERIFYING ACTUAL FIELD CONDITIONS

Before commencing work, examine all adjoining work on which the contractor's work that is dependent for perfect workmanship according to the intent of this specification section, and report to the Contracting Officer's Representative a condition that prevents performance of first class work. No "waiver of responsibility" for incomplete, inadequate or defective adjoining work will be considered unless notice has been filed before submittal of a proposal.

Perform fire-hydrant flow test according to NFPA 13 and NFPA 291. Use results for system design calculations required in "Quality Assurance" Article. Report test results promptly and in writing.

3.2 INSTALLATION

The installation must be in accordance with the applicable provisions of NFPA 13, NFPA 24 and publications referenced therein. Locate sprinklers in a consistent pattern with ceiling grid, lights, and air supply diffusers. Install sprinkler system over and under ducts, piping and platforms when such equipment can negatively affect or disrupt the sprinkler discharge pattern and coverage.

- a. Piping offsets, fittings, and other accessories required must be furnished to provide a complete installation and to eliminate interference with other construction.
- b. Wherever the contractor's work interconnects with work of other trades the Contractor must coordinate with other Contractors to insure all Contractors have the information necessary so that they may properly install all necessary connections and equipment. Identify all work items needing access (dampers and similar equipment) that are concealed above hung ceilings by permanent color coded pins/tabs in the ceiling directly below the item.
- c. Provide required supports and hangers for piping, conduit, and equipment so that loading will not exceed allowable loadings of structure. Submittal of a bid must be a deemed representation that the contractor submitting such bid has ascertained allowable loadings and has included in his estimates the costs associated in furnishing required supports.

3.2.1 Waste Removal

At the conclusion of each day's work, clean up and stockpile on site all waste, debris, and trash which may have accumulated during the day as a result of work by the contractor and of his presence on the job. Sidewalks and streets adjoining the property must be kept broom clean and free of waste, debris, trash and obstructions caused by work of the contractor, which will affect the condition and safety of streets, walks, utilities, and property.

3.3 UNDERGROUND PIPING INSTALLATION

The fire protection water main must be laid, and joints anchored, in accordance with NFPA 24. Minimum depth of cover must be 3 feet or the frost line, whichever is deeper. The supply line must terminate inside the building with a flanged piece, the bottom of which must be set not less than 1-foot above the finished floor. A blind flange must be installed temporarily on top of the flanged piece to prevent the entrance of foreign matter into the supply line. A concrete thrust block must be provided at the elbow where the pipe turns up toward the floor. In addition, joints must be anchored in accordance with NFPA 24. Buried steel components must be provided with a corrosion protective coating in accordance with AWWA C203.

3.4 ABOVEGROUND PIPING INSTALLATION

The methods of fabrication and installation of the aboveground piping must fully comply with the requirements and recommended practices of NFPA 13 and this specification section.

3.4.1 Piping in Exposed Areas

Install exposed piping without diminishing exit access widths, corridors or equipment access. Exposed horizontal piping, including drain piping, must be installed to provide maximum headroom.

3.4.2 Piping in Finished Areas

In areas with suspended or dropped ceilings and in areas with concealed spaces above the ceiling, piping must be concealed above ceilings. Piping must be inspected, hydrostatically tested and approved before being concealed. Risers and similar vertical runs of piping in finished areas must be concealed.

3.4.3 Pendent Sprinklers

- a. Drop nipples to pendent sprinklers must consist of minimum 1-inch pipe with a reducing coupling into which the sprinkler must be threaded.
- b. Where sprinklers are installed below suspended or dropped ceilings, drop nipples must be cut such that sprinkler ceiling plates or escutcheons are of a uniform depth throughout the finished space. The outlet of the reducing coupling must not extend below the underside of the ceiling.
- c. Recessed pendent sprinklers must be installed such that the distance from the sprinkler deflector to the underside of the ceiling must not exceed the manufacturer's listed range and must be of uniform depth throughout the finished area.
- d. Pendent sprinklers in suspended ceilings must be located in the center of the tile (plus or minus 2 inches).
- e. Install dry-type sprinklers with water supply from heated space. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing.
- f. Dry pendent sprinkler assemblies must be such that sprinkler ceiling plates or escutcheons are of the uniform depth throughout the finished space.

- g. Dry pendent sprinklers must be of the required length to permit the sprinkler to be threaded directly into a branch line tee.
- h. Where the maximum static or flowing pressure, whichever is greater at the sprinkler, applied other than through the fire department connection, exceeds 100 psi and a branch line above the ceiling supplies sprinklers in a pendent position below the ceiling, the cumulative horizontal length of an unsupported armover to a sprinkler or sprinkler drop must not exceed 12 inches for steel pipe and 6 inches for copper tube.

3.4.4 Upright Sprinklers

Riser nipples or "sprigs" to upright sprinklers must contain no fittings between the branch line tee and the reducing coupling at the sprinkler.

3.4.5 Sprinkler Schedule

- a. Use sprinkler types in subparagraphs below for the following applications:
 - (1) Rooms without Ceilings: Upright sprinklers.
 - (2) Rooms with Suspended Ceilings: Pendent, recessed, flush, and concealed sprinklers as indicated.
 - (3) Wall Mounting: Sidewall sprinklers.
 - (4) Spaces Subject to Freezing: Upright, pendent, dry sprinklers; and sidewall, dry sprinklers as indicated.
 - (5) Special Applications: Extended-coverage, flow-control, and quick-response sprinklers where indicated, Attic sprinklers, and Institutional space sprinklers.
- b. Provide sprinkler types in subparagraphs below with finishes indicated.
 - (1) Concealed Sprinklers: Rough brass, with factory-painted white cover plate.
 - (2) Flush Sprinklers: Bright chrome, with painted white escutcheon.
 - (3) Recessed Sprinklers: Bright chrome, with bright chrome escutcheon.
 - (4) Upright, Pendent and Sidewall Sprinklers: Chrome plated in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view; wax coated where exposed to acids, chemicals, or other corrosive fumes.

3.4.6 Pipe Joints

Pipe joints must conform to NFPA 13, except as modified herein. Not more than four threads must show after joint is made up. Welded joints will be permitted, only if welding operations are performed as required by NFPA 13 at the Contractor's fabrication shop, not at the project construction site. Flanged joints must be provided where indicated or required by NFPA 13. Grooved pipe and fittings must be prepared in accordance with

the manufacturer's latest published specification according to pipe material, wall thickness and size. Grooved couplings, fittings and grooving tools must be products of the same manufacturer. For copper tubing, pipe and groove dimensions must comply with the tolerances specified by the coupling manufacturer. The diameter of grooves made in the field must be measured using a "go/no-go" gauge, vernier or dial caliper, narrow-land micrometer, or other method specifically approved by the coupling manufacturer for the intended application. Groove width and dimension of groove from end of pipe must be measured and recorded for each change in grooving tool setup to verify compliance with coupling manufacturer's tolerances.

3.4.7 Reducers

Reductions in pipe sizes must be made with one-piece tapered reducing fittings. When standard fittings of the required size are not manufactured, single bushings of the face or hex type will be permitted. Where used, face bushings must be installed with the outer face flush with the face of the fitting opening being reduced. Bushings cannot be used in elbow fittings, in more than one outlet of a tee, in more than two outlets of a cross, or where the reduction in size is less than 1/2-inch.

3.4.8 Pipe Penetrations

- a. Cutting structural members for passage of pipes or for pipe-hanger fastenings will not be permitted. Pipes that must penetrate concrete or masonry walls or concrete floors must be core-drilled and provided with pipe sleeves. Each sleeve must be Schedule 40 galvanized steel, ductile-iron or cast-iron pipe and extend through its respective wall or floor and be cut flush with each wall surface. Sleeves must provide required clearance between the pipe and the sleeve per NFPA 13. The space between the sleeve and the pipe must be firmly packed with mineral wool insulation.
- b. Where pipes and sleeves penetrate fire walls, fire partitions, or floors, pipes/sleeves must be firestopped in accordance with Section 07 84 00 FIRESTOPPING.
- c. In penetrations that are not fire-rated or not a floor penetration, the space between the sleeve and the pipe must be sealed at both ends with plastic waterproof cement that will dry to a firm but pliable mass or with a mechanically adjustable segmented elastomer seal.
- d. All penetrations through the boundary of rooms/areas identified as secure space area must meet ICS 705-1.

3.4.9 Escutcheons

Escutcheons must be provided for pipe penetration in finished areas of ceilings, floors and walls. Escutcheons must be securely fastened to the pipe at surfaces through which piping passes.

3.4.10 Inspector's Test Connection

Install "Inspector's Test Connection" in sprinkler system piping, complete with shutoff valve, and sized and located according to NFPA 13. Unless otherwise indicated, the test connection must consist of 1-inch pipe connected at the riser as a combination test and drain valve; a test valve located approximately 7 feet above the floor; a smooth bore brass outlet

equivalent to the smallest orifice sprinkler used in the system; and a painted metal identification sign affixed to the valve with the words "Inspector's Test". All test connection piping must be inside of the building and penetrate the exterior wall at the location of the discharge orifice only. The discharge orifice must be located outside the building wall no more than 2 feet above finished grade, directed so as not to cause damage to adjacent construction or landscaping during full flow discharge, or to the sanitary sewer. Discharge to the exterior must not interfere with exiting from the facility. Water discharge or runoff must not cross the path of egress from the building. Do not discharge to the roof. Discharge to floor drains, janitor sinks or similar fixtures is not permitted.

Provide concrete splash blocks at all drain and inspector's test connection discharge locations if not discharging to a concrete surface. Splash blocks must be large enough to mitigate erosion and not become dislodged during a full flow of the drain. Ensure all discharged water drains away from the facility and does not cause property damage.

3.4.11 Backflow Preventer

Locate within the building or in a heated enclosure in locations subject to freezing. For heated enclosures, provide a low temperature supervisory alarm connected to the facility fire alarm system. Heat trace is not permitted to be used.

Install backflow preventers so that the bottom of the assembly is a minimum of 6 inches above the finished floor/grade. Install horizontal backflow preventers so that the bottom of the assembly is no greater than 24 inches above the finished floor/grade. Install vertical backflow preventers so that the upper operating handwheel is no more than 6 feet above the finished floor/grade. Clearance around control valve handles must be minimum 6 inches above grade/finished floor and away from walls.

3.4.12 Drains

- a. Main drain piping must be provided to discharge at a safe point outside the building, no more than 2 feet above finished grade. Provide a concrete splash block at drain outlet. Discharge to the exterior must not interfere with exiting from the facility. Water discharge or runoff must not cross the path of egress from the building.
- b. Auxiliary drains must be provided as required by NFPA 13. Auxiliary drains are permitted to discharge to a floor drain if the drain is sized to accommodate full flow (min 40 gpm). Discharge to service sinks or similar plumbing fixtures is not permitted.

3.4.13 Installation of Fire Department Connection

Connection must be mounted adjacent to and on the sprinkler system side of the backflow preventer. The piping between the connection and the check valve must be provided with an automatic drip in accordance with NFPA 13 and piped to drain to the outside or a floor drain within the same room.

3.4.14 Identification Signs

Signs must be affixed to each control valve, inspector test valve, main drain, auxiliary drain, test valve, and similar valves as appropriate or

as required by NFPA 13. Main drain test results must be etched into main drain identification sign. Hydraulic design data must be etched into the nameplates and permanently affixed to each sprinkler riser as specified in NFPA 13. Provide labeling on the surfaces of all feed and cross mains to show the pipe function (e.g., "Sprinkler System", "Fire Department Connection", "Standpipe") and normal valve position (e.g. "Normally Open", "Normally Closed"). For pipe sizes 4-inch and larger provide white painted stenciled letters and arrows, a minimum of 2 inches in height and visible from at least two sides when viewed from the floor. For pipe sizes less than 4-inch, provide white painted stenciled letters and arrows, a minimum of 0.75-inch in height and visible from the floor.

3.5 ELECTRICAL

Except as modified herein, electric equipment and wiring must be in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Alarm signal wiring connected to the building fire alarm control system must be by the fire alarm installer.

3.6 PAINTING

Color code mark piping red.

3.7 FIELD QUALITY CONTROL

3.7.1 Test Procedures

Submit detailed test procedures, prepared and signed by the NICET Level III or IV Fire Sprinkler Technician, and the representative of the installing company, and reviewed by the QFPE 60 days prior to performing system tests. Detailed test procedures must list all components of the installed system. Test procedures must include sequence of testing, time estimate for each test, and sample test data forms. The test data forms must be in a check-off format (pass/fail with space to add applicable test data; similar to the forms in NFPA 13). The test procedures and accompanying test data forms must be used for the pre-Government testing and the Government final testing.

- a. Provide space to identify the date and time of each test. Provide space to identify the names and signatures of the individuals conducting and witnessing each test.

3.7.1.1 Minimum Testing Required

- a. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - (1) Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
 - (2) Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - (3) Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
 - (4) Energize circuits to electrical equipment and devices.
 - (5) Coordinate with fire-alarm tests. Operate as required.

(6) Coordinate with fire-pump tests. Operate as required.

(7) Verify that equipment hose threads are same as local fire department equipment.

b. Sprinkler piping system will be considered defective if it does not pass tests and inspections.

3.7.2 Pre-Government Testing

3.7.2.1 Verification of Compliant Installation

Conduct inspections and tests to ensure that equipment is functioning properly. Tests must meet the requirements of paragraph entitled "Minimum System Tests" and "System Acceptance" as noted in NFPA 13. The Contractor and QFPE must be in attendance at the pre-Government testing to make necessary adjustments. After inspection and testing is complete, provide a signed Verification of Compliant Installation letter by the QFPE that the installation is complete, compliant with the specification and fully operable. The letter must include the names and titles of the witnesses to the pre-Government tests. Provide all completion documentation as required by NFPA 13 and the test reports noted below.

a. NFPA 13 Aboveground Material and Test Certificate

b. NFPA 13 Underground Material and Test Certificate

3.7.2.2 Request for Government Final Test

When the verification of compliant installation has been completed, submit a formal request for Government final test to the Contracting Officers Designated Representative (COR). Government final testing will not be scheduled until the DFPE has received copies of the request for Government final testing and Verification of Compliant Installation letter with all required reports. Government final testing will not be performed until after the connections to the building fire alarm system have been completed and tested to confirm communications are fully functional. Submit request for test at least 15 calendar days prior to the requested test date.

3.7.3 Correction of Deficiencies

If equipment was found to be defective or non-compliant with contract requirements, perform corrective actions and repeat the tests. Tests must be conducted and repeated if necessary until the system has been demonstrated to comply with all contract requirements.

3.7.4 Government Final Tests

The tests must be performed in accordance with the approved test procedures in the presence of the DFPE. Furnish instruments and personnel required for the tests. The following must be provided at the job site for Government Final Testing:

a. The manufacturer's technical representative.

b. The contractor's Qualified Fire Protection Engineer (QFPE).

- c. Marked-up red line drawings of the system as actually installed.

Government Final Tests will be witnessed by the Designated Fire Protection Engineer and Contracting Officer. At this time, all required tests noted in the paragraph "Minimum System Tests" must be repeated at their discretion.

3.8 MINIMUM SYSTEM TESTS

The system, including the underground water mains, and the aboveground piping and system components, must be tested to ensure that equipment and components function as intended. The underground and aboveground interior piping systems and attached appurtenances subjected to system working pressure must be tested in accordance with NFPA 13 and NFPA 24.

3.8.1 Underground Piping

3.8.1.1 Flushing

Underground piping must be flushed at a minimum of 10 fps in accordance with NFPA 24.

3.8.1.2 Hydrostatic Test

New underground piping must be hydrostatically tested in accordance with NFPA 24.

3.8.2 Aboveground Piping

3.8.2.1 Hydrostatic Test

Aboveground piping must be hydrostatically tested in accordance with NFPA 13. There must be no drop in gauge pressure or visible leakage when the system is subjected to the hydrostatic test. The test pressure must be read from a gauge located at the low elevation point of the system or portion being tested.

3.8.2.2 Backflow Prevention Assembly Forward Flow Test

Each backflow prevention assembly must be tested at system flow demand, including all applicable hose streams, as specified in NFPA 13. The Contractor must provide all equipment and instruments necessary to conduct a complete forward flow test, including 2.5-inch diameter hoses, playpipe nozzles or flow diffusers, calibrated pressure gauges, and pitot tube gauge. The Contractor must provide all necessary supports to safely secure hoses and nozzles during the test. At the system demand flow, the pressure readings and pressure drop (friction loss) across the assembly must be recorded. A metal placard must be provided on the backflow prevention assembly that lists the pressure readings both upstream and downstream of the assembly, total pressure drop, and the system test flow rate determined during the preliminary testing. The pressure drop must be compared to the manufacturer's data and the readings observed during the final inspections and tests.

3.8.3 Main Drain Flow Test

Following flushing of the underground piping, a main drain test must be made to verify the adequacy of the water supply. Static and residual pressures must be recorded on the certificate specified in paragraph

SUBMITTALS.

3.9 SYSTEM ACCEPTANCE

Following acceptance of the system, **as-built drawings** and O&M manuals must be delivered to the Contracting Officer for review and acceptance. Submit six sets of detailed as-built drawings. The drawings must show the system as installed, including deviations from both the project drawings and the approved shop drawings. These drawings must be submitted within two weeks after the final acceptance test of the system. At least one set of as-built (marked-up) drawings must be provided at the time of, or prior to the final acceptance test.

- a. Provide one set of full size paper as-built drawings and schematics. The drawings must be prepared electronically and sized no less than the contract drawings.
- b. Provide **operating and maintenance (O&M) instructions**.

3.10 ONSITE TRAINING

Conduct a training course for the responding fire department and operating and maintenance personnel as designated by the Contracting Officer. Training must be performed on two separate days (to accommodate different shifts of Fire Department personnel) for a period of 4 hours of normal working time and must start after the system is functionally complete and after the final acceptance test. The on-site training must cover all of the items contained in the approved Operating and Maintenance Instructions **and train Owner's maintenance personnel to adjust, operate, and maintain specialty valves and pressure-maintenance pumps.**

-- End of Section --

SECTION 22 00 00

PLUMBING, GENERAL PURPOSE
11/15, CHG 4: 05/21

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

- ANSI Z21.10.1/CSA 4.1 (2019) Gas Water Heaters Vol. I, Storage Water Heaters with Input Ratings of 75,000 Btu Per Hour or Less
- ANSI Z21.10.3/CSA 4.3 (2019) Gas-Fired Water Heaters Vol.III, Storage Water Heaters With Input Ratings Above 75,000 Btu Per Hour, Circulating and Instantaneous
- ANSI Z21.22/CSA 4.4 (2015; R 2020) Relief Valves for Hot Water Supply Systems

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

- ASCE 7-10 (2010; Errata 2011; Supp 1 2013) Minimum Design Loads for Buildings and Other Structures

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

- ASHRAE 90.1 - IP (2019; Errata 1 2019; Errata 2-5 2020; Addenda BY-CP 2020; Addenda AF-DB 2020; Addenda A-G 2020; Addenda F-Y 2021; Errata 6-8 2021; Interpretation 1-4 2020; Interpretation 5-8 2021 Addenda AS-AQ 2022) Energy Standard for Buildings Except Low-Rise Residential Buildings

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

- ASME A112.1.2 (2012; R 2017; R 2022) Air Gaps in Plumbing Systems (For Plumbing Fixtures and Water-Connected Receptors)
- ASME A112.6.1M (1997; R 2017) Floor Affixed Supports for Off-the-Floor Plumbing Fixtures for Public Use
- ASME A112.6.3 (2019) Standard for Floor and Trench Drains
- ASME A112.6.4 (2003; R 2012) Roof, Deck and Balcony Drains

ASME A112.14.1	(2003; R 2017; R 2022) Backwater Valves
ASME A112.18.1/CSA B125.1	(2018) Plumbing Supply Fittings
ASME A112.19.2/CSA B45.1	(2018; ERTA 2018) Standard for Vitreous China Plumbing Fixtures and Hydraulic Requirements for Water Closets and Urinals
ASME A112.19.5	(2022) Flush Valves and Spuds for Water Closets, Urinals, and Tanks
ASME A112.36.2M	(1991; R 2017) Cleanouts
ASME B1.20.1	(2013; R 2018) Pipe Threads, General Purpose (Inch)
ASME B1.20.7	(1991; R 2013) Standard for Hose Coupling Screw Threads (Inch)
ASME B16.1	(2020) Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250
ASME B16.3	(2021) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.4	(2021) Gray Iron Threaded Fittings; Classes 125 and 250
ASME B16.5	(2020) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B16.10	(2022) Face-to-Face and End-to-End Dimensions of Valves
ASME B16.12	(2019) Cast Iron Threaded Drainage Fittings
ASME B16.15	(2018) Cast Copper Alloy Threaded Fittings Classes 125 and 250
ASME B16.18	(2021) Cast Copper Alloy Solder Joint Pressure Fittings
ASME B16.21	(2021) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.22	(2021) Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B16.23	(2021) Cast Copper Alloy Solder Joint Drainage Fittings - DWV
ASME B16.24	(2022) Cast Copper Alloy Pipe Flanges, Flanged Fittings, and Valves Classes 150, 300, 600, 900, 1500, and 2500
ASME B16.29	(2017) Wrought Copper and Wrought Copper Alloy Solder-Joint Drainage Fittings - DWV

ASME B16.34	(2021) Valves - Flanged, Threaded and Welding End
ASME B16.50	(2021) Wrought Copper and Copper Alloy Braze-Joint Pressure Fittings
ASME B16.51	(2013) Copper and Copper Alloy Press-Connect Pressure Fittings
ASME B31.1	(2022) Power Piping
ASME B31.5	(2020) Refrigeration Piping and Heat Transfer Components
ASME B31.9	(2020) Building Services Piping
ASME B40.100	(2013) Pressure Gauges and Gauge Attachments
ASME B40.200	(2008; R 2013) Thermometers, Direct Reading and Remote Reading
ASME BPVC SEC IV	(2017) BPVC Section IV-Rules for Construction of Heating Boilers
ASME BPVC SEC IX	(2017; Errata 2018) BPVC Section IX-Welding, Brazing and Fusing Qualifications
ASME CSD-1	(2021) Control and Safety Devices for Automatically Fired Boilers

AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)

ASSE 1001	(2021) Performance Requirements for Atmospheric Type Vacuum Breakers
ASSE 1010	(2021) Performance Requirements for Water Hammer Arresters
ASSE 1011	(2017) Performance Requirements for Hose Connection Vacuum Breakers
ASSE 1012	(2021) Performance Requirements for Backflow Preventer with an Intermediate Atmospheric Vent
ASSE 1013	(2021) Performance Requirements for Reduced Pressure Principle Backflow Prevention Assemblies
ASSE 1018	(2001; R 2021) Performance Requirements for Trap Seal Primer Valves - Potable Water Supplied (ANSI Approved 2002)
ASSE 1020	(2020) Performance Requirements for Pressure Vacuum Breaker Assemblies
ASSE 1037	(2015; R 2020) Performance Requirements

for Pressurized Flushing Devices for
Plumbing Fixtures

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA 10084	(2017) Standard Methods for the Examination of Water and Wastewater
AWWA B300	(2018) Hypochlorites
AWWA B301	(2018) Liquid Chlorine
AWWA C203	(2020) Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot-Applied
AWWA C606	(2015) Grooved and Shouldered Joints
AWWA C651	(2014) Standard for Disinfecting Water Mains
AWWA C652	(2019) Disinfection of Water-Storage Facilities
AWWA C700	(2020) Cold-Water Meters - Displacement Type, Metal Alloy Main Case
AWWA C701	(2019) Cold-Water Meters - Turbine Type for Customer Service
AWWA D100	(2021) Welded Steel Tanks for Water Storage

AMERICAN WELDING SOCIETY (AWS)

AWS A5.8/A5.8M	(2019) Specification for Filler Metals for Brazing and Braze Welding
AWS B2.2/B2.2M	(2016) Specification for Brazing Procedure and Performance Qualification

ASTM INTERNATIONAL (ASTM)

ASTM A47/A47M	(1999; R 2022; E 2022) Standard Specification for Ferritic Malleable Iron Castings
ASTM A53/A53M	(2022) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A74	(2021) Standard Specification for Cast Iron Soil Pipe and Fittings
ASTM A105/A105M	(2021) Standard Specification for Carbon Steel Forgings for Piping Applications
ASTM A183	(2014; R 2020) Standard Specification for Carbon Steel Track Bolts and Nuts

ASTM A193/A193M	(2022a) Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service and Other Special Purpose Applications
ASTM A515/A515M	(2017; R2022) Standard Specification for Pressure Vessel Plates, Carbon Steel, for Intermediate- and Higher-Temperature Service
ASTM A516/A516M	(2017) Standard Specification for Pressure Vessel Plates, Carbon Steel, for Moderate- and Lower-Temperature Service
ASTM A518/A518M	(1999; R 2022) Standard Specification for Corrosion-Resistant High-Silicon Iron Castings
ASTM A536	(1984; R 2019; E 2019) Standard Specification for Ductile Iron Castings
ASTM A888	(2021a) Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications
ASTM B32	(2020) Standard Specification for Solder Metal
ASTM B42	(2020) Standard Specification for Seamless Copper Pipe, Standard Sizes
ASTM B43	(2020) Standard Specification for Seamless Red Brass Pipe, Standard Sizes
ASTM B75/B75M	(2020) Standard Specification for Seamless Copper Tube
ASTM B88	(2022) Standard Specification for Seamless Copper Water Tube
ASTM B117	(2019) Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM B152/B152M	(2019) Standard Specification for Copper Sheet, Strip, Plate, and Rolled Bar
ASTM B306	(2020) Standard Specification for Copper Drainage Tube (DWV)
ASTM B370	(2022) Standard Specification for Copper Sheet and Strip for Building Construction
ASTM B584	(2022) Standard Specification for Copper Alloy Sand Castings for General Applications
ASTM B813	(2016) Standard Specification for Liquid and Paste Fluxes for Soldering of Copper

and Copper Alloy Tube

ASTM C533	(2017) Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation
ASTM C552	(2022) Standard Specification for Cellular Glass Thermal Insulation
ASTM C564	(2020a) Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings
ASTM C920	(2018) Standard Specification for Elastomeric Joint Sealants
ASTM C1053	(2000; R 2010) Standard Specification for Borosilicate Glass Pipe and Fittings for Drain, Waste, and Vent (DWV) Applications
ASTM D2000	(2018) Standard Classification System for Rubber Products in Automotive Applications
ASTM D2235	(2004; R 2016) Standard Specification for Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings
ASTM D2564	(2020) Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
ASTM D2657	(2007; R 2015) Heat Fusion Joining Polyolefin Pipe and Fittings
ASTM D2661	(2014; E 2018) Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40, Plastic Drain, Waste, and Vent Pipe and Fittings
ASTM D2665	(2014) Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings
ASTM D2822/D2822M	(2005; R 2011; E 2011) Standard Specification for Asphalt Roof Cement, Asbestos-Containing
ASTM D2855	(2015) Standard Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings
ASTM D2996	(2017) Standard Specification for Filament-Wound "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe
ASTM D3122	(1995; R 2009) Solvent Cements for Styrene-Rubber (SR) Plastic Pipe and Fittings

ASTM D3138	(2004; R 2016) Standard Specification for Solvent Cements for Transition Joints Between Acrylonitrile-Butadiene-Styrene (ABS) and Poly(Vinyl Chloride) (PVC) Non-Pressure Piping Components
ASTM D3139	(2019) Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
ASTM D3212	(2020) Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
ASTM D3311	(2017) Standard Specification for Drain, Waste, and Vent (DWV) Plastic Fittings Patterns
ASTM D4101	(2017) Standard Classification System and Basis for Specification for Polypropylene Injection and Extrusion Materials
ASTM E1	(2014) Standard Specification for ASTM Liquid-in-Glass Thermometers
ASTM F409	(2022) Standard Specification for Thermoplastic Accessible and Replaceable Plastic Tube and Tubular Fittings
ASTM F477	(2014; R 2021) Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F493	(2022) Standard Specification for Solvent Cements for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe and Fittings
ASTM F628	(2022) Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe with a Cellular Core
ASTM F891	(2016) Standard Specification for Coextruded Poly (Vinyl Chloride) (PVC) Plastic Pipe with a Cellular Core
ASTM F1290	(2019) Standard Practice for Electrofusion Joining Polyolefin Pipe and Fittings
ASTM F1760	(2016; R 2020) Standard Specification for Coextruded Poly(Vinyl Chloride) (PVC) Non-Pressure Plastic Pipe Having Reprocessed-Recycled Content
ASTM F2389	(2021) Standard Specification for Pressure-rated Polypropylene (PP) Piping Systems

CAST IRON SOIL PIPE INSTITUTE (CISPI)

- CISPI 301 (2018) Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications
- CISPI 310 (2012) Coupling for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications

COPPER DEVELOPMENT ASSOCIATION (CDA)

- CDA A4015 (2016; 14/17) Copper Tube Handbook

INTERNATIONAL ASSOCIATION OF PLUMBING AND MECHANICAL OFFICIALS (IAPMO)

- IAPMO PS 117 (2005b) Press Type Or Plain End Rub Gasketed W/ Nail CU & CU Alloy Fittings 4 Install On CU Tubing
- IAPMO UPC (2003) Uniform Plumbing Code

INTERNATIONAL CODE COUNCIL (ICC)

- ICC A117.1 (2017) Standard And Commentary Accessible and Usable Buildings and Facilities
- ICC IPC (2021) International Plumbing Code
- ICC/ANSI A117.1 (2009) Accessible and Usable Buildings and Facilities

INTERNATIONAL SAFETY EQUIPMENT ASSOCIATION (ISEA)

- ANSI/ISEA Z358.1 (2014) American National Standard for Emergency Eyewash and Shower Equipment

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

- MSS SP-25 (2018) Standard Marking System for Valves, Fittings, Flanges and Unions
- MSS SP-45 (2020) Bypass and Drain Connections
- MSS SP-58 (2018) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation
- MSS SP-67 (2022) Butterfly Valves
- MSS SP-69 (2003; Notice 2012) Pipe Hangers and Supports - Selection and Application (ANSI Approved American National Standard)
- MSS SP-70 (2011) Gray Iron Gate Valves, Flanged and Threaded Ends

MSS SP-71	(2018) Gray Iron Swing Check Valves, Flanged and Threaded Ends
MSS SP-72	(2010a) Ball Valves with Flanged or Butt-Welding Ends for General Service
MSS SP-78	(2011) Cast Iron Plug Valves, Flanged and Threaded Ends
MSS SP-80	(2019) Bronze Gate, Globe, Angle and Check Valves
MSS SP-85	(2011) Gray Iron Globe & Angle Valves Flanged and Threaded Ends
MSS SP-110	(2010) Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends

NACE INTERNATIONAL (NACE)

NACE SP0169	(2013) Control of External Corrosion on Underground or Submerged Metallic Piping Systems

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2020) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA MG 1	(2021) Motors and Generators
NEMA MG 11	(1977; R 2012) Energy Management Guide for Selection and Use of Single Phase Motors

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 54	(2021) National Fuel Gas Code
NFPA 90A	(2021) Standard for the Installation of Air Conditioning and Ventilating Systems

NSF INTERNATIONAL (NSF)

NSF 372	(2016) Drinking Water System Components - Lead Content
NSF/ANSI 14	(2021) Plastics Piping System Components and Related Materials
NSF/ANSI 61	(2022) Drinking Water System Components - Health Effects

PLASTIC PIPE AND FITTINGS ASSOCIATION (PPFA)

PPFA Fire Man	(2016) Firestopping: Plastic Pipe in Fire Resistive Construction

PLUMBING AND DRAINAGE INSTITUTE (PDI)

PDI WH 201 (2010) Water Hammer Arresters Standard

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

SAE J1508 (2009) Hose Clamp Specifications

U.S. DEPARTMENT OF ENERGY (DOE)

Energy Star (1992; R 2006) Energy Star Energy
Efficiency Labeling System (FEMP)

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

PL 93-523 (1974; A 1999) Safe Drinking Water Act

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

10 CFR 430 Energy Conservation Program for Consumer
Products

40 CFR 141.80 National Primary Drinking Water
Regulations; Control of Lead and Copper;
General Requirements

1.2 SUBMITTALS

Government approval is required for submittals . Submit the following in
accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Plumbing System

Detail drawings consisting of schedules, performance charts, instructions, diagrams, and other information to illustrate the requirements and operations of systems that are not covered by the Plumbing Code. Detail drawings for the complete plumbing system including piping layouts and locations of connections; dimensions for roughing-in, foundation, and support points; schematic diagrams and wiring diagrams or connection and interconnection diagrams. Detail drawings shall indicate clearances required for maintenance and operation. Where piping and equipment are to be supported other than as indicated, details shall include loadings and proposed support methods. Mechanical drawing plans, elevations, views, and details, shall be drawn to scale.

Pipe Hangers, Inserts, And Supports

SD-03 Product Data

Backflow Prevention Assemblies

Flush Valve Water Closets

Flush Valve Urinals

Wall Hung Lavatories

Drinking-Water Coolers

Water Heaters

Pumps

Welding

A copy of qualified procedures and a list of names and identification symbols of qualified welders and welding operators.

Vibration-Absorbing Features

Details of vibration-absorbing features, including arrangement, foundation plan, dimensions and specifications.

Plumbing System

Diagrams, instructions, and other sheets proposed for posting. Manufacturer's recommendations for the installation of bell and spigot and hubless joints for cast iron soil pipe.

Pipe Sleeves

Fixtures

SD-06 Test Reports

Tests, Flushing and Disinfection

Test reports in booklet form showing all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria, completion and testing of the installed system. Each test report shall indicate the final position of controls.

Test of Backflow Prevention Assemblies

Certification of proper operation shall be as accomplished in accordance with state regulations by an individual certified by the state to perform such tests. If no state requirement exists, the Contractor shall have the manufacturer's representative test the device, to ensure the unit is properly installed and performing as intended. The Contractor shall provide written documentation of the tests performed and signed by the individual performing the tests.

Water Heaters

SD-07 Certificates

Materials and Equipment

Where equipment is specified to conform to requirements of the ASME Boiler and Pressure Vessel Code, the design, fabrication, and installation shall conform to the code.

Bolts

Written certification by the bolt manufacturer that the bolts furnished comply with the specified requirements.

Utility Department Certification

For each location and type of Utility service to be supplied and requirements for service.

Qualification Of Plumbing Contractor

Instruction To Government Personnel

Meters And Gages

SD-10 Operation and Maintenance Data

Plumbing System

Meters And Gages

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

SD-11 Closeout Submittals

Plumbing System

1.3 STANDARD PRODUCTS

Specified materials and equipment shall be standard products of a manufacturer regularly engaged in the manufacture of such products. Specified equipment shall essentially duplicate equipment that has performed satisfactorily at least two years prior to bid opening. Standard products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year use shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2 year period.

1.3.1 Alternative Qualifications

Products having less than a two-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturer's factory or laboratory tests, can be shown.

1.3.2 Service Support

The equipment items shall be supported by service organizations. Submit a certified list of qualified permanent service organizations for support of the equipment which includes their addresses and qualifications. These service organizations shall be reasonably convenient to the equipment installation and able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

1.3.3 Manufacturer's Nameplate

Each item of equipment shall have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

1.3.4 Modification of References

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction", or words of similar meaning, to mean the Contracting Officer.

1.3.4.1 Definitions

For the International Code Council (ICC) Codes referenced in the contract documents, advisory provisions shall be considered mandatory, the word "should" shall be interpreted as "shall." Reference to the "code official" shall be interpreted to mean the "Contracting Officer." For Navy owned property, references to the "owner" shall be interpreted to mean the "Contracting Officer." For leased facilities, references to the "owner" shall be interpreted to mean the "lessor." References to the "permit holder" shall be interpreted to mean the "Contractor."

1.3.4.2 Administrative Interpretations

For ICC Codes referenced in the contract documents, the provisions of Chapter 1, "Administrator," do not apply. These administrative requirements are covered by the applicable Federal Acquisition Regulations (FAR) included in this contract and by the authority granted to the Officer in Charge of Construction to administer the construction of this project. References in the ICC Codes to sections of Chapter 1, shall be applied appropriately by the Contracting Officer as authorized by his administrative cognizance and the FAR.

1.4 UTILITY CONNECTIONS

Arrange with utility department for utility service connections, taps, meters and installation. Pay all fees and charges, if any, necessary for the utility services shown on the drawings or listed in the specifications.

Re-confirm with the Utility Department, prior to bidding, that locations, arrangements, line sizes, pressures, interruptions, shut downs, etc., are in accordance with their regulations and requirements.

If the Utility Department requirements are at variance with these drawings and specifications, include the Utility Department requirements in the work without additional cost to the Government.

Furnish with shop drawings a signed document from each Utility Department describing location and type of service to be supplied and requirements for service. Document shall be signed by the appropriate responsible representative of the respective Utility Department.

1.5 DELIVERY, STORAGE, AND HANDLING

Handle, store, and protect equipment and materials to prevent damage

before and during installation in accordance with the manufacturer's recommendations, and as approved by the Contracting Officer. Replace damaged or defective items.

1.6 PERFORMANCE REQUIREMENTS

1.6.1 Qualification Of Plumbing Contractor

- a. Has completed minimum two projects same size and scope in past five (5) years.
- b. Use workmen experienced in their respective trade. Submit qualifications of Superintendent for review.
- c. Government reserves right to reject bid of any Plumbing Contractor failing to meet these qualifications.

1.6.2 Welding

Piping shall be welded in accordance with qualified procedures using performance-qualified welders and welding operators. Procedures and welders shall be qualified in accordance with ASME BPVC SEC IX. Welding procedures qualified by others, and welders and welding operators qualified by another employer, may be accepted as permitted by ASME B31.1. The Contracting Officer shall be notified 24 hours in advance of tests, and the tests shall be performed at the work site if practicable. Welders or welding operators shall apply their assigned symbols near each weld they make as a permanent record.

1.6.3 Cathodic Protection and Pipe Joint Bonding

Cathodic protection and pipe joint bonding systems shall be in accordance with.

1.7 REGULATORY REQUIREMENTS

Unless otherwise required herein, plumbing work shall be in accordance with ICC IPC.

Obtain and pay for all permits required for the work. Comply with all ordinances pertaining to work described herein.

Arrange, pay for and complete work to pass required tests by agencies having authority over work. Deliver to Contracting Officer the Certificates of Inspection and approval issued by authorities.

1.8 PROJECT/SITE CONDITIONS

The Contractor shall become familiar with details of the work, verify dimensions in the field, and advise the Contracting Officer of any discrepancy before performing any work.

1.9 INSTRUCTION TO GOVERNMENT PERSONNEL

When specified in other sections, furnish the services of competent instructors to give full instruction to the designated Government personnel in the adjustment, operation, and maintenance, including pertinent safety requirements, of the specified equipment or system. Instructors shall be thoroughly familiar with all parts of the

installation and shall be trained in operating theory as well as practical operation and maintenance work.

Instruction shall be given during the first regular work week after the equipment or system has been accepted and turned over to the Government for regular operation. The number of man-days (8 hours per day) of instruction furnished shall be as specified in the individual section. When more than 4 man-days of instruction are specified, use approximately half of the time for classroom instruction. Use other time for instruction with the equipment or system.

When significant changes or modifications in the equipment or system are made under the terms of the contract, provide additional instruction to acquaint the operating personnel with the changes or modifications.

1.10 ACCESSIBILITY OF EQUIPMENT

Install all work so that parts requiring periodic inspection, operation, maintenance, and repair are readily accessible. Install concealed valves, expansion joints, controls, dampers, and equipment requiring access, in locations freely accessible through access doors.

1.11 WARRANTIES

Provide a written warranty, stating that if workmanship and/or materials executed under this Division is proven defective within one (1) year after substantial completion, such defects and other work damaged will be repaired and/or replaced.

PART 2 PRODUCTS

2.1 MATERIALS

Materials for various services shall be in accordance with TABLES I and II.

Pipe schedules shall be selected based on service requirements. Pipe fittings shall be compatible with the applicable pipe materials. Plastic pipe, fittings, and solvent cement shall meet NSF/ANSI 14 and shall be NSF listed for the service intended. Plastic pipe, fittings, and solvent cement used for potable hot and cold water service shall bear the NSF seal "NSF-PW." Polypropylene pipe and fittings shall conform to dimensional requirements of Schedule 40, Iron Pipe size and shall comply with NSF/ANSI 14, NSF/ANSI 61 and ASTM F2389. Polypropylene piping that will be exposed to UV light shall be provided with a Factory applied UV resistant coating. Pipe threads (except dry seal) shall conform to ASME B1.20.1. Grooved pipe couplings and fittings shall be from the same manufacturer. Material or equipment containing a weighted average of greater than 0.25 percent lead shall not be used in any potable water system intended for human consumption, and shall be certified in accordance with NSF/ANSI 61, Annex G or NSF 372. In line devices such as water meters, building valves, check valves, meter stops, valves, fittings and back flow preventers shall comply with PL 93-523 and NSF/ANSI 61, Section 8. End point devices such as drinking water fountains, lavatory faucets, kitchen and bar faucets, residential ice makers, supply stops and end point control valves used to dispense water for drinking must meet the requirements of NSF/ANSI 61, Section 9. Hubless cast-iron soil pipe shall not be installed underground, under concrete floor slabs, or in crawl spaces below kitchen floors. Plastic pipe shall not be installed in air plenums. Plastic pipe shall not be installed in a pressure piping system in buildings greater than three stories including any basement levels.

2.1.1 Pipe Joint Materials

Grooved pipe and hubless cast-iron soil pipe shall not be used underground. Solder containing lead shall not be used with copper pipe. Cast iron soil pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Institute. Joints and gasket materials shall conform to the following:

- a. Coupling for Cast-Iron Pipe: for hub and spigot type [ASTM A74](#), [AWWA C606](#). For hubless type: [CISPI 310](#)
- b. Coupling for Steel Pipe: [AWWA C606](#).
- c. Couplings for Grooved Pipe: Ductile Iron [ASTM A536](#) (Grade 65-45-12), Malleable Iron [ASTM A47/A47M](#), Grade 32510.
- d. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.
- e. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
- f. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
- g. Copper Unions: MSS SP-123; cast-copper-alloy, hexagonal-stock body; Ball-and-socket, metal-to-metal seating surfaces; Solder-joint or threaded ends.
- h. Flange Gaskets: Gaskets shall be made of non-asbestos material in accordance with [ASME B16.21](#). Gaskets shall be flat, 1/16 inch thick, and contain Aramid fibers bonded with Styrene Butadiene Rubber (SBR) or Nitro Butadiene Rubber (NBR). Gaskets shall be the full face or self centering flat ring type. Gaskets used for hydrocarbon service shall be bonded with NBR.
- i. Brazing Material: Brazing material shall conform to [AWS A5.8/A5.8M](#), BCuP-5.
- j. Brazing Flux: Flux shall be in paste or liquid form appropriate for use with brazing material. Flux shall be as follows: lead-free; have a 100 percent flushable residue; contain slightly acidic reagents; contain potassium borides; and contain fluorides.
- k. Solder Material: Solder metal shall conform to [ASTM B32](#), lead free alloys.
- l. Solder Flux: Flux shall be liquid form, non-corrosive, and conform to [ASTM B813](#), Standard Test 1.
- m. PTFE Tape: PTFE Tape, for use with Threaded Metal or Plastic Pipe.
- n. Rubber Gaskets for Cast-Iron Soil-Pipe and Fittings (hub and spigot type and hubless type): [ASTM C564](#).
- o. Rubber Gaskets for Grooved Pipe: [ASTM D2000](#), maximum temperature 230 degrees F.
- p. Flexible Elastomeric Seals: [ASTM D3139](#), [ASTM D3212](#) or [ASTM F477](#).

- q. Bolts and Nuts for Grooved Pipe Couplings: Heat-treated carbon steel, **ASTM A183**.
- r. Solvent Cement for Transition Joints between ABS and PVC Nonpressure Piping Components: **ASTM D3138**.
- s. Plastic Solvent Cement for ABS Plastic Pipe: **ASTM D2235**.
- t. Plastic Solvent Cement for PVC Plastic Pipe: **ASTM D2564** and **ASTM D2855**.
- u. Plastic Solvent Cement for CPVC Plastic Pipe: **ASTM F493**.
- v. Flanged fittings including, but not limited to, flanges, bolts, nuts and bolt patterns shall be in accordance with **ASME B16.5** class 150 and shall have the manufacturer's trademark affixed in accordance with **MSS SP-25**. Flange material shall conform to **ASTM A105/A105M**. Blind flange material shall conform to **ASTM A516/A516M** cold service and **ASTM A515/A515M** for hot service. Bolts shall be high strength or intermediate strength with material conforming to **ASTM A193/A193M**.
- w. Plastic Solvent Cement for Styrene Rubber Plastic Pipe: **ASTM D3122**.
- x. Press fittings for Copper Pipe and Tube: Copper press fittings shall conform to the material and sizing requirements of **ASME B16.51** and performance criteria of **IAPMO PS 117**. Sealing elements for copper press fittings shall be EPDM, FKM or HNBR. Sealing elements shall be factory installed or an alternative supplied fitting manufacturer. Sealing element shall be selected based on manufacturer's approved application guidelines.
- y. Copper tubing shall conform to **ASTM B88**, Type K, L or M.
- z. Heat-fusion joints for polypropylene piping: **ASTM F2389**.

Dielectric Fittings: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

- a. Dielectric Unions: ASSE 1079; Pressure Rating, 150 psig; Solder-joint copper alloy and threaded ferrous.
- b. Dielectric Flanges: ASSE 1079; Factory-fabricated, bolted, companion-flange assembly; pressure Rating, 150 psig; Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.
- c. Dielectric Nipples: IAPMO PS 66; Electroplated steel nipple complying with ASTM F 1545; Pressure Rating and Temperature, 300 psig at 225 deg F.; Male threaded or grooved; Inert and noncorrosive, propylene lining.

2.1.2 Miscellaneous Materials

Miscellaneous materials shall conform to the following:

- a. Water Hammer Arrester: ASSE 1010 or **PDI WH 201**. Copper tube with piston; ASSE 1010, Sizes AA and A through F, or PDI-WH 201, Sizes A through F.

- b. Copper, Sheet and Strip for Building Construction: **ASTM B370**.
- c. Asphalt Roof Cement: **ASTM D2822/D2822M**.
- d. Hose Clamps: **SAE J1508**.
- e. Supports for Off-The-Floor Plumbing Fixtures: **ASME A112.6.1M**.
- f. Metallic Cleanouts: **ASME A112.36.2M**.
- g. Plumbing Fixture Setting Compound: A preformed flexible ring seal molded from hydrocarbon wax material. The seal material shall be nonvolatile nonasphaltic and contain germicide and provide watertight, gastight, odorproof and verminproof properties.
- h. Coal-Tar Protective Coatings and Linings for Steel Water Pipelines: **AWWA C203**.
- i. Hypochlorites: **AWWA B300**.
- j. Liquid Chlorine: **AWWA B301**.
- k. Gauges - Pressure and Vacuum Indicating Dial Type - Elastic Element: **ASME B40.100**.
- l. Thermometers: **ASTM E1**. Mercury shall not be used in thermometers.

2.1.3 Pipe Insulation Material

Insulation shall be as specified in Section **23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS**.

2.2 PIPE HANGERS, INSERTS, AND SUPPORTS

Pipe hangers, inserts, and supports shall conform to **MSS SP-58**.

Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

Hangers and supports for plumbing piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE 7-10.

- a. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
- b. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

2.2.1 METAL PIPE HANGERS AND SUPPORTS

- a. Carbon-Steel Pipe Hangers and Supports:

(1) Description: MSS SP-58, Types 1 through 58, factory-fabricated components.

(2) Galvanized Metallic Coatings: Pregalvanized or hot dipped.

- (3) Nonmetallic Coatings: Plastic coating, jacket, or liner.
- (4) Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
- (5) Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

b. Stainless-Steel Pipe Hangers and Supports:

- (1) Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
- (2) Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
- (3) Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

c. Copper Pipe Hangers:

- (1) Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
- (1) Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel or stainless steel.

2.2.2 TRAPEZE PIPE HANGERS

MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.2.3 FIBERGLASS PIPE HANGERS

a. Clevis-Type, Fiberglass Pipe Hangers:

- (1) Description: Similar to MSS SP-58, Type 1, steel pipe hanger except hanger is made of fiberglass or fiberglass-reinforced resin.
- (2) Hanger Rods: Continuous-thread rod, washer, and nuts made of polyurethane or stainless steel.

b. Strap-Type, Fiberglass Pipe Hangers:

- (1) Description: Similar to MSS SP-58, Type 9 or Type 10, steel pipe hanger except hanger is made of fiberglass-reinforced resin.
- (2) Hanger Rod and Fittings: Continuous-thread rod, washer, and nuts made of stainless steel.

2.2.4 METAL FRAMING SYSTEMS

a. MFMA Manufacturer Metal Framing Systems:

- (1) Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.

- (2) Standard: MFMA-4.
- (3) Channels: Continuous slotted steel channel with inturned lips.
- (4) Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
- (5) Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
- (6) Metallic Coating: Electroplated zinc or Hot-dipped galvanized.
- (7) Paint Coating: Vinyl, Vinyl alkyd or Epoxy.
- (8) Plastic Coating: PVC.

2.2.5 FIBERGLASS STRUT SYSTEMS

- a. Description: Shop- or field-fabricated pipe-support assembly similar to MFMA-4 for supporting multiple parallel pipes.
 - (1) Channels: Continuous slotted fiberglass or other plastic channel with inturned lips.
 - (2) Channel Nuts: Fiberglass nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
 - (3) Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

2.2.6 THERMAL-HANGER SHIELD INSERTS

- a. Insulation-Insert Material for Cold Piping: ASTM C552, Type II cellular glass with 100-psig minimum compressive strength and vapor barrier.
- b. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C533, Type I calcium silicate with 100-psig or ASTM C552, Type II cellular glass with 100-psig minimum compressive strength.
- c. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- d. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- e. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.2.7 FASTENER SYSTEMS

- a. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
- b. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated or stainless steel anchors, for use in hardened portland cement concrete;

with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.2.8 Pipe Stands

- a. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.
- b. Compact Pipe Stand: One-piece plastic unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.
- c. Low-Type, Single-Pipe Stand: One-piece stainless-steel base unit with plastic roller, for roof installation without membrane penetration.
- d. High-Type, Single-Pipe Stand:
 - (1) Description: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
 - (2) Base: Stainless steel.
 - (3) Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.
 - (4) Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.
- e. High-Type, Multiple-Pipe Stand:
 - (1) Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
 - (2) Bases: One or more; plastic.
 - (3) Vertical Members: Two or more protective-coated-steel channels.
 - (4) Horizontal Member: Protective-coated-steel channel.
 - (5) Pipe Supports: Galvanized-steel, clevis-type pipe hangers.
- f. Curb-Mounting-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

2.2.9 Pipe Positioning Systems

IAPMO PS 42, positioning system of metal brackets, clips, and straps for positioning piping in pipe spaces; for plumbing fixtures in commercial applications.

2.2.10 Equipment Supports

Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.3 VALVES

Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

- a. ASME Compliance:
 - (1) ASME B1.20.1 for threads for threaded end valves.
 - (2) ASME B16.1 for flanges on iron valves.
 - (3) ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
 - (4) ASME B16.18 for solder joint.
 - (5) ASME B31.9 for building services piping valves.
- b. AWWA Compliance: Comply with AWWA C606 for grooved-end connections.
- c. NSF Compliance: NSF/ANSI 61 Annex G and NSF 372 for valve materials for potable-water service.
- d. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.
- e. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- f. Valve Sizes: Same as upstream piping unless otherwise indicated.
- g. Valve Bypass and Drain Connections: MSS SP-45.
- h. Valve Actuator Types:
 - (1) Gear Actuator: For quarter-turn valves NPS 4 and larger.
 - (2) Handlever: For quarter-turn valves smaller than NPS 4.
- i. Valves in Insulated Piping:
 - (1) Include 2-inch stem extensions.
 - (2) Extended operating handles of nonthermal-conductive material and protective sleeves that allow operation of valves without breaking vapor seals or disturbing insulation.
 - (3) Memory stops that are fully adjustable after insulation is applied.

Valves shall be provided on supplies to equipment and fixtures. Valves 2-1/2 inches and smaller shall be bronze with threaded bodies for pipe and solder-type connections for tubing. Valves 3 inches and larger shall have flanged iron bodies and bronze trim. Pressure ratings shall be based upon the application. Grooved end valves may be provided if the manufacturer certifies that the valves meet the performance requirements of applicable MSS standard. Valves shall conform to the following standards:

Description	Standard
Butterfly Valves	MSS SP-67
Cast-Iron Gate Valves, Flanged and Threaded Ends	MSS SP-70
Cast-Iron Swing Check Valves, Flanged and Threaded Ends	MSS SP-71
Ball Valves with Flanged Butt-Welding Ends for General Service	MSS SP-72
Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends	MSS SP-110
Cast-Iron Plug Valves, Flanged and Threaded Ends	MSS SP-78
Bronze Gate, Globe, Angle, and Check Valves	MSS SP-80
Steel Valves, Socket Welding and Threaded Ends	ASME B16.34
Cast-Iron Globe and Angle Valves, Flanged and Threaded Ends	MSS SP-85
Backwater Valves	ASME A112.14.1
Vacuum Relief Valves	ANSI Z21.22/CSA 4.4
Water Heater Drain Valves	ASME BPVC SEC IV, Part HLW-810: Requirements for Potable-Water Heaters Bottom Drain Valve
Trap Seal Primer Valves	ASSE 1018
Temperature and Pressure Relief Valves for Hot Water Supply Systems	ANSI Z21.22/CSA 4.4
Temperature and Pressure Relief Valves for Automatically Fired Hot Water Boilers	ASME CSD-1 Safety Code No., Part CW, Article 5

2.3.1 Backwater Valves

Backwater valves shall be either separate from the floor drain or a combination floor drain, P-trap, and backwater valve, as shown. Valves shall have cast-iron bodies with cleanouts large enough to permit removal of interior parts. Valves shall be of the flap type, hinged or pivoted, with revolving disks. Hinge pivots, disks, and seats shall be nonferrous metal. Disks shall be slightly open in a no-flow no-backwater condition. Cleanouts shall extend to finished floor and be fitted with threaded countersunk plugs.

2.3.2 Copper Alloy Calibrated Balancing Valves:

- a. Type: Ball valve with two readout ports and memory-setting indicator.
- b. Body: Bronze.
- c. Size: Same as connected piping, but not larger than NPS 2.
- d. Accessories: Meter hoses, fittings, valves, differential pressure meter, and carrying case.

2.3.3 Self-Regulating Balancing Device

- a. Typical Fixture: Circuite Solver.
- b. Pressure Rating: 200-psig minimum CWP.
- c. Size: Line Size.
- d. Body: Stainless Steel.
- e. Working Temperature: 300 deg F maximum.
- f. Certification: NSF-61.
- g. End Connections: Threaded.

2.3.4 Wall Faucets

Wall faucets with vacuum-breaker backflow preventer shall be brass with 3/4 inch male inlet threads, hexagon shoulder, and 3/4 inch hose connection. Faucet handle shall be securely attached to stem.

2.3.5 Wall Hydrants (Frostproof)

- a. Standard: ASME A112.21.3M for concealed or exposed-outlet, self-draining wall hydrants.
- b. Pressure Rating: 125 psig.
- c. Operation: Loose key.
- d. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
- e. Inlet: NPS 3/4.
- f. Outlet: Concealed, with integral vacuum breaker and garden-hose thread

complying with ASME B1.20.7.

- g. Box: Deep, flush mounted with cover.
- h. Box and Cover Finish: Polished nickel bronze.
- i. Outlet: Exposed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
- j. Nozzle and Wall-Plate Finish: Rough bronze.
- k. Operating Keys(s): One with each wall hydrant.

2.3.6 Relief Valves

Water heaters and hot water storage tanks shall have a combination pressure and temperature (P&T) relief valve. The pressure relief element of a P&T relief valve shall have adequate capacity to prevent excessive pressure buildup in the system when the system is operating at the maximum rate of heat input. The temperature element of a P&T relief valve shall have a relieving capacity which is at least equal to the total input of the heaters when operating at their maximum capacity. Relief valves shall be rated according to ANSI Z21.22/CSA 4.4. Relief valves for systems where the maximum rate of heat input is less than 200,000 Btuh shall have 3/4 inch minimum inlets, and 3/4 inch outlets. Relief valves for systems where the maximum rate of heat input is greater than 200,000 Btuh shall have 1 inch minimum inlets, and 1 inch outlets. The discharge pipe from the relief valve shall be the size of the valve outlet.

2.3.7 Thermostatic Mixing Valves

Provide thermostatic mixing valve for lavatory faucets. Mixing valves, thermostatic type, pressure-balanced or combination thermostatic and pressure-balanced shall be line size and shall be constructed with rough or finish bodies either with or without plating. Each valve shall be constructed to control the mixing of hot and cold water and to deliver water at a desired temperature regardless of pressure or input temperature changes. The control element shall be of an approved type. The body shall be of heavy cast bronze, and interior parts shall be brass, bronze, corrosion-resisting steel or copper. The valve shall be equipped with necessary stops, check valves, unions, and sediment strainers on the inlets. Mixing valves shall maintain water temperature within 5 degrees F of any setting.

2.4 FIXTURES

Water closet replacements in major renovations may have a flush valve of up to 1.6 GPF to accommodate existing plumbing capacity. Fixtures for use by the physically handicapped shall be in accordance with ICC A117.1. Vitreous China, nonabsorbent, hard-burned, and vitrified throughout the body shall be provided. Porcelain enameled ware shall have specially selected, clear white, acid-resisting enamel coating evenly applied on surfaces. No fixture will be accepted that shows cracks, crazes, blisters, thin spots, or other flaws. Fixtures shall be equipped with appurtenances such as traps, faucets, stop valves, and drain fittings. Each fixture and piece of equipment requiring connections to the drainage system, except grease interceptors, shall be equipped with a trap. Brass expansion or toggle bolts capped with acorn nuts shall be provided for supports, and polished chromium-plated pipe, valves, and fittings shall be

provided where exposed to view. Fixtures with the supply discharge below the rim shall be equipped with backflow preventers. Internal parts of flush valves and flushometer valves, shower mixing valves, shower head face plates, pop-up stoppers of lavatory waste drains, and pop-up stoppers and overflow tees and shoes of bathtub waste drains.

2.4.1 Automatic Controls

Flushing and faucet systems shall consist of solenoid-activated valves with light beam sensors. Flush valve for water closet shall include an override pushbutton. Flushing devices shall be provided as described in paragraph FIXTURES AND FIXTURE TRIMMINGS.

2.4.2 Flush Valve Water Closets

2.4.2.1 Water Closets, WC-1:

a. Description: Floor mounted, bottom outlet, top spud.

(1) Bowl:

- a) Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5.
- b) Material: Vitreous china.
- c) Type: Siphon jet.
- d) Style: Flushometer valve.
- e) Height: Handicapped/elderly, complying with ICC/ANSI A117.1.
- f) Rim Contour: Elongated.
- g) Water Consumption: 1.6 gal. per flush.
- h) Spud Size and Location: NPS 1-1/2, top.
- i) Color: White.

(2) Bowl-to-Drain Connecting Fitting: ASTM A1045 or ASME A112.4.3.

(3) Flushometer Valve: FV-1.

(4) Toilet Seat: TS-1.

2.4.2.2 Water Closets, WC-2

a. Description: Floor mounted, bottom outlet, top spud, accessible (high).

(1) Bowl:

- a) Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5.
- b) Material: Vitreous china.
- c) Type: Siphon jet.
- d) Style: Flushometer valve.

- e) Height: Handicapped/elderly, complying with ICC/ANSI A117.1.
 - f) Rim Contour: Elongated.
 - g) Water Consumption: 1.6 gal. per flush.
 - h) Spud Size and Location: NPS 1-1/2, top.
 - i) Color: White.
- (2) Bowl-to-Drain Connecting Fitting: ASTM A 1045 or ASME A112.4.3.
 - (3) Flushometer Valve: FV-1.
 - (4) Toilet Seat: TS-1.

2.4.2.3 FLUSHOMETER VALVES

a. Lever-Handle, Piston Flushometer Valves, FV-1

- 1. Standard: ASSE 1037.
- 2. Minimum Pressure Rating: 125 psig.
- 3. Features: Include integral check stop and backflow-prevention device.
- 4. Material: Brass body with corrosion-resistant components.
- 5. Exposed Flushometer-Valve Finish: Chrome plated.
- 6. Panel Finish: Chrome plated or stainless steel.
- 7. Style: Exposed.
- 8. Consumption: 1.6 gal. per flush.
- 9. Minimum Inlet: NPS 1.
- 10. Minimum Outlet: NPS 1-1/4.

2.4.2.4 TOILET SEATS, TS-1

- (1) Standard: IAPMO/ANSI Z124.5.
- (2) Material: Plastic.
- (3) Type: Commercial (Heavy duty).
- (4) Shape: Elongated rim, open front.
- (5) Hinge: Check with Sta-Tite Assembly.
- (6) Hinge Material: Noncorroding metal.
- (7) Seat Cover: Not required.
- (8) Color: White.

2.4.3 Flush Valve Urinals

2.4.3.1 Urinals, UR-1

a. Description: Wall hung, back outlet, washout.

(1) Fixture:

- a) Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5.
- b) Material: Vitreous china.
- c) Type: Washout with extended shields.
- d) Strainer or Trapway: Manufacturer's standard strainer with integral trap.
- e) Water Consumption: 1.0 gal. per flush.
- f) Spud Size and Location: NPS 3/4, top.
- g) Outlet Size and Location: NPS 2, back.
- h) Color: White.

(2) Flushometer Valve: FV-1.

(3) Waste Fitting:

- a) Standard: ASME A112.18.2/CSA B125.2 for coupling.
- b) Size: NPS 2.

(4) Support: Type II Urinal Carrier with fixture support plates and coupling with seal and fixture bolts and hardware matching fixture. Include rectangular, steel uprights.

(5) Urinal Mounting Height: Standard.

2.4.3.2 Urinals, UR-2

a. Description: Wall hung, back outlet, washout, accessible.

(1) Fixture:

- a) Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5.
- b) Material: Vitreous china.
- c) Type: Washout with extended shields.
- d) Strainer or Trapway: Manufacturer's standard strainer with integral trap.
- e) Water Consumption: 1.0 gal. per flush.
- f) Spud Size and Location: NPS 3/4, top.
- g) Outlet Size and Location: NPS 2, back.

- h) Color: White.
- (2) Flushometer Valve: FV-1.
- (3) Waste Fitting:
 - a) Standard: ASME A112.18.2/CSA B125.2 for coupling.
 - b) Size: NPS 2.
- (4) Support: Type II Urinal Carrier with fixture support plates and coupling with seal and fixture bolts and hardware matching fixture. Include rectangular, steel uprights.
- (5) Urinal Mounting Height: Handicapped/elderly according to ICC A117.1.

2.4.3.3 URINAL FLUSHOMETER VALVES

a Description: Lever-Handle, Piston Flushometer Valves, FV-1:

- (1) Standard: ASSE 1037.
- (2) Minimum Pressure Rating: 125 psig.
- (3) Features: Include integral check stop and backflow-prevention device.
- (4) Material: Brass body with corrosion-resistant components.
- (5) Exposed Flushometer-Valve Finish: Chrome plated.
- (6) Panel Finish: Chrome plated or stainless steel.
- (7) Style: Exposed.
- (8) Consumption: 1.0 gal. per flush.
- (9) Minimum Inlet: NPS 3/4.
- (10) Minimum Outlet: NPS 3/4.

2.4.3.4 SUPPORTS

- a. Type II Urinal Carrier:
 - 2. Standard: ASME A112.6.1M.

2.4.4 Wall Hung Lavatories

A. 2.4.4.1 Lavatory, LV-1

- a. Description: Vitreous china, wall mounted, with back.
 - (1) Fixture: ASME A112.19.2/CSA B45.1.; Nominal Size, Rectangular 20-3/4 by 18-1/4 inches;

(2) Faucet-Hole Punching: Single hole, location on top.

(3) Color: White.

(4) Mounting Material: Chair carrier.

b. Faucet: LVF-1.

c. Support: Type II, concealed-arm lavatory carrier. Include rectangular, steel uprights.

d. Lavatory Mounting Height: Handicapped/elderly according to ICC A117.1.

e. Temperature Limiting Device: Required.

2.4.4.2 Lavatory, LV-2

a. Description: Oval, self-rimming, vitreous china, counter mounted.

(1) Fixture: ASME A112.19.2/CSA B45.1; Self-rimming for above-counter mounting; Nominal Size, Oval, 20 by 17 inches.

(2) Faucet-Hole Punching: Single hole.

(3) Faucet-Hole Location: Top.

(4) Color: White.

(5) Mounting Material: Sealant.

b. Faucet: LVF-1.

c. Temperature Limiting Device: Required.

2.4.4.3 Solid-Brass, Manually Operated Faucets

a. NSF Standard: Comply with NSF/ANSI 61 Annex G, "Drinking Water System Components - Health Effects," for faucet materials that will be in contact with potable water.

b. Lavatory Faucets, LVF-1: Manual-type, single-control mixing, commercial, solid-brass valve.

(1) Standard: ASME A112.18.1/CSA B125.1.

(2) General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and fixture receptor.

(3) Body Type: Single Hole.

(4) Body Material: Commercial, solid brass.

(5) Finish: Polished chrome plate.

(6) Maximum Flow Rate: 0.5 gpm.

(7) Mounting Type: Deck, exposed.

- (8) Valve Handle(s): Single lever.
- (9) Spout: Rigid type.
- (10) Spout Outlet: Aerator.
- (11) Operation: Compression, manual.
- (12) Drain: Not part of faucet.

2.4.4.4 SUPPLY FITTINGS

- a. NSF Standard: Comply with NSF/ANSI 61 Annex G, "Drinking Water System Components - Health Effects," for supply-fitting materials that will be in contact with potable water.
 - (1) Standard: ASME A112.18.1/CSA B125.1.
- b. Supply Piping: Chrome-plated-brass pipe or chrome-plated copper tube matching water-supply piping size. Include chrome-plated-brass or stainless-steel wall flange.
- c. Supply Stops: Chrome-plated-brass, one-quarter-turn, ball-type or compression valve with inlet connection matching supply piping.
- d. Operation: Loose key.
- e. Risers: NPS 3/8 or NPS 1/2; Chrome-plated, soft-copper flexible tube or ASME A112.18.6, braided- or corrugated-stainless-steel, flexible hose riser.

2.4.4.5 WASTE FITTINGS

- a. Standard: ASME A112.18.2/CSA B125.2.
- b. Drain: Grid type with NPS 1-1/4 offset and straight tailpiece.
- c. Trap: NPS 1-1/2 by NPS 1-1/4; Chrome-plated, two-piece, cast-brass trap and swivel elbow with 17-gauge thick brass tube to wall; and chrome-plated, brass or steel wall flange.

2.4.5 Drinking-Water Coolers

- a. Pressure Water Coolers, EWC-1: Wall Mounted, bi-level, bottle filler.
 - (1) Cabinet: Bi-level with two attached stainless-steel cabinets with stainless-steel tops.
 - (2) Bubbler: One, with adjustable stream regulator, located on each cabinet.
 - (3) Control: Push bar.
 - (4) Bottle Filler: Sensor activation with automatic shutoff timer. Fill rate 0.5 to 1.5 gpm.
 - (5) Drain: Grid with NPS 1-1/4 tailpiece.
 - (6) Supply: NPS 3/8 with shutoff valve.

- (7) Waste Fitting: ASME A112.18.2/CSA B125.2, NPS 1-1/4 brass P-trap.
- (8) Filter: One or more water filters complying with NSF 42 and NSF 53 for cyst and lead reduction to below EPA standards; with capacity sized for unit peak flow rate.
- (9) Cooling System: Electric, with hermetically sealed compressor, cooling coil, air cooled condensing unit, corrosion-resistant tubing, refrigerant, corrosion-resistant-metal storage tank, and adjustable thermostat.
 - a) Electrical Component Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- (10) Capacities and Characteristics:
 - a) Cooled Water: 8gph.
 - b) Ambient-Air Temperature: 90 deg F.
 - c) Inlet-Water Temperature: 80 deg F.
 - d) Cooled-Water Temperature: 50 deg F.
 - e) Electrical Characteristics: Volts, 120-V ac; Phase Single; Hertz 60.
- (11) Support: Type II Water Cooler Carrier.
- (12) Water Cooler Mounting Height: Standard.

b. Supports

- (1) Type II Water Cooler Carrier: ASME A112.6.1M.

2.4.6 Emergency Eye and Face Wash

ANSI/ISEA Z358.1, Pedestal-mounted self-cleaning, nonclogging eye and face wash with quick opening, full-flow valves, stainless steel or chrome plated brass eye and face wash receptor. Unit shall deliver 3 gpm of aerated water at 30 psig flow pressure for at least 15 minutes, with eye and face wash nozzles 33 to 45 inches above finished floor. Provide copper alloy control mixing valves. Provide an air-gap with the lowest potable eye and face wash water outlet located above the overflow rim by not less than the International Plumbing Code minimum. NPS 1/2 chrome-plated brass or stainless steel supply piping with flow regulator and stay-open control valve with paddle actuator. Spray-Head Assembly shall be a two or four receptor-mounted spray heads. Drain Piping shall incorporate NPS 1-1/4 minimum, chrome-plated brass, receptor drain, P-trap, waste to wall, and wall flange complying with ASME A112.18.2/CSA B125.2.

Thermostatic Mixing Valve: Designed to provide 85 deg F tepid, potable water at emergency plumbing fixtures, to maintain temperature at plus or minus 5 deg F throughout required 15-minute test period, and in case of unit failure to continue cold-water flow, with union connections,

controls, metal piping, and corrosion-resistant enclosure.

2.5 BACKFLOW PREVENTERS

Backflow prevention devices must be approved by the State or local regulatory agencies. If there is no State or local regulatory agency requirements, the backflow prevention devices must be listed by the Foundation for Cross-Connection Control & Hydraulic Research, or any other approved testing laboratory having equivalent capabilities for both laboratory and field evaluation of backflow prevention devices and assemblies.

Reduced pressure principle assemblies, double check valve assemblies, atmospheric (nonpressure) type vacuum breakers, and pressure type vacuum breakers shall meet the above requirements.

Backflow preventers with intermediate atmospheric vent shall conform to ASSE 1012. Reduced pressure principle backflow preventers shall conform to ASSE 1013. Hose connection vacuum breakers shall conform to ASSE 1011. Pipe applied atmospheric type vacuum breakers shall conform to ASSE 1001. Pressure vacuum breaker assembly shall conform to ASSE 1020. Air gaps in plumbing systems shall conform to ASME A112.1.2.

2.6 DRAINS

2.6.1 Floor Drains

Floor drains shall consist of a galvanized body, integral seepage pan, and adjustable perforated or slotted chromium-plated bronze, nickel-bronze, or nickel-brass strainer, consisting of grate and threaded collar. Floor drains shall be cast iron except where metallic waterproofing membrane is installed. Drains shall be of double drainage pattern for embedding in the floor construction. The seepage pan shall have weep holes or channels for drainage to the drainpipe. The strainer shall be adjustable to floor thickness. A clamping device for attaching flashing or waterproofing membrane to the seepage pan without damaging the flashing or waterproofing membrane shall be provided when required. Drains shall be provided with threaded connection. Between the drain outlet and waste pipe, a neoprene rubber gasket conforming to ASTM C564 may be installed, provided that the drain is specifically designed for the rubber gasket compression type joint. Floor drains shall conform to ASME A112.6.3. Provide drain with trap primer connection, trap primer, and connection piping. Primer shall meet ASSE 1018.

2.6.1.1 Drains and Backwater Valves

Drains and backwater valves installed in connection with waterproofed floors or shower pans shall be equipped with bolted-type device to securely clamp flashing.

2.6.2 Area Drains

Area drains shall be plain pattern with polished stainless steel perforated or slotted grate and bottom outlet. The drain shall be circular or square with a 12 inch nominal overall width or diameter and 10 inch nominal overall depth. Drains shall be cast iron with manufacturer's standard coating. Grate shall be easily lifted out for cleaning. Outlet shall be suitable for inside caulked connection to drain pipe. Drains shall conform to ASME A112.6.3.

2.6.3 Boiler Room Drains

Boiler room drains shall have combined drain and trap, hinged grate, removable bucket, and threaded brass cleanout with brass backwater valve. The removable galvanized cast-iron sediment bucket shall have rounded corners to eliminate fouling and shall be equipped with hand grips. Drain shall have a minimum water seal of 4 inches. The grate area shall be not less than 100 square inches.

2.6.4 Sight Drains

Sight drains shall consist of body, integral seepage pan, and adjustable strainer with perforated or slotted grate and funnel extension. The strainer shall have a threaded collar to permit adjustment to floor thickness. Drains shall be of double drainage pattern suitable for embedding in the floor construction. A clamping device for attaching flashing or waterproofing membrane to the seepage pan without damaging the flashing or membrane shall be provided for other than concrete construction. Drains shall have a galvanized heavy cast-iron body and seepage pan and chromium-plated bronze, nickel-bronze, or nickel-brass strainer and funnel combination. Drains shall be provided with threaded connection and with a separate cast-iron "P" trap, unless otherwise indicated. Drains shall be circular, unless otherwise indicated. The funnel shall be securely mounted over an opening in the center of the strainer. Minimum dimensions shall be as follows:

Area of strainer and collar: 36 square inches

Height of funnel: 3-3/4 inches

Diameter of lower portion: 2 inches of funnel

Diameter of upper portion: 4 inches of funnel

2.6.5 Roof Drains and Expansion Joints

Roof drains shall conform to ASME A112.6.4, with dome and integral flange, and shall have a device for making a watertight connection between roofing and flashing. The whole assembly shall be galvanized heavy pattern cast iron. For aggregate surface roofing, the drain shall be provided with a gravel stop. On roofs other than concrete construction, roof drains shall be complete with underdeck clamp, sump receiver, and an extension for the insulation thickness where applicable. A clamping device for attaching flashing or waterproofing membrane to the seepage pan without damaging the flashing or membrane shall be provided when required to suit the building construction. Strainer openings shall have a combined area equal to twice that of the drain outlet. The outlet shall be equipped to make a proper connection to threaded pipe of the same size as the downspout. An expansion joint of proper size to receive the conductor pipe shall be provided. The expansion joint shall consist of a heavy cast-iron housing, brass or bronze sleeve, brass or bronze fastening bolts and nuts, and gaskets or packing. The sleeve shall have a nominal thickness of not less than 0.134 inch. Gaskets and packing shall be close-cell neoprene, O-ring packing shall be close-cell neoprene of 70 durometer. Packing shall be held in place by a packing gland secured with bolts.

2.6.6 Trap-Seal Primer Device

Supply-Type, Trap-Seal Primer Device: ASSE 1018; pressure Rating, 125 psig minimum; Bronze body; Inlet and Outlet Connections, NPS 1/2 threaded, union, or solder joint; Gravity Drain Outlet Connection, NPS 1/2 threaded or solder joint; Chrome plated, or rough bronze for units used with pipe or tube that is not chrome finished.

2.7 TRAPS

Unless otherwise specified, traps shall be plastic per ASTM F409 or copper-alloy adjustable tube type with slip joint inlet and swivel as indicated. Traps shall be without a cleanout. Provide traps with removable access panels for easy clean-out at sinks and lavatories. Tubes shall be copper alloy with walls not less than 0.032 inch thick within commercial tolerances, except on the outside of bends where the thickness may be reduced slightly in manufacture by usual commercial methods. Inlets shall have rubber washer and copper alloy nuts for slip joints above the discharge level. Swivel joints shall be below the discharge level and shall be of metal-to-metal or metal-to-plastic type as required for the application. Nuts shall have flats for wrench grip. Outlets shall have internal pipe thread, except that when required for the application, the outlets shall have sockets for solder-joint connections. The depth of the water seal shall be not less than 2 inches. The interior diameter shall be not more than 1/8 inch over or under the nominal size, and interior surfaces shall be reasonably smooth throughout. A copper alloy "P" trap assembly consisting of an adjustable "P" trap and threaded trap wall nipple with cast brass wall flange shall be provided for lavatories. The assembly shall be a standard manufactured unit and may have a rubber-gasketed swivel joint.

2.8 WATER HEATERS

Water heater types and capacities shall be as indicated. Each water heater shall have replaceable anodes. Each primary water heater shall have controls with an adjustable range that includes 90 to 160 degrees F. Each gas-fired water heater and booster water heater shall have controls with an adjustable range that includes 120 to 180 degrees F. Hot water systems utilizing recirculation systems shall be tied into building off-hour controls. The thermal efficiencies and standby heat losses shall conform to TABLE III in PART 3 of this Section for each type of water heater specified. The only exception is that storage water heaters and hot water storage tanks having more than 500 gallons storage capacity need not meet the standard loss requirement if the tank surface area is insulated to R-12.5 and if a standing light is not used. Plastic materials polyetherimide (PEI) and polyethersulfone (PES) are forbidden to be used for vent piping of combustion gases. A factory pre-charged expansion tank shall be installed on the cold water supply to each water heater. Expansion tanks shall be specifically designed for use on potable water systems and shall be rated for 200 degrees F water temperature and 150 psi working pressure. The expansion tank size and acceptance volume shall be as indicated.

2.8.1 Automatic Storage Type

Heaters shall be complete with control system, and shall have ASME rated combination pressure and temperature relief valve.

2.8.1.1 Gas-Fired Type

Gas-fired water heaters shall conform to ANSI Z21.10.1/CSA 4.1 when input is 75,000 BTU per hour or less or ANSI Z21.10.3/CSA 4.3 for heaters with input greater than 75,000 BTU per hour. Provide Energy Star labeled gas storage water heater.

- a. Commercial, Gas-Fired, High-Efficiency, Storage, Domestic-Water Heaters: ANSI Z21.10.3/CSA 4.3; Manufacturer's proprietary design to provide at least 93 percent combustion efficiency at optimum operating conditions.

- (1) Concentric Vent Kit: Required, through roof application.
- (2) Acid Neutralization Kit: Required.
- (3) Storage-Tank Construction: ASME-code steel with 150-psig minimum working-pressure rating.

- a) Tappings: Factory fabricated of materials compatible with tank. Attach tappings to tank before testing.

- 1. NPS 2 and Smaller: Threaded ends according to ASME B1.20.1.

- 2. NPS 2-1/2 and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges and according to ASME B16.24 for copper and copper-alloy flanges.

- b) Interior Finish: Comply with NSF 61 Annex G barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.

- c) Lining: Glass or Nickel plate complying with NSF 61 Annex G barrier materials for potable-water tank linings, including extending lining into and through tank fittings and outlets.

- (4) Factory-Installed Storage-Tank Appurtenances:

- a) Anode Rod: Replaceable magnesium.

- b) Dip Tube: Required unless cold-water inlet is near bottom of tank.

- c) Drain Valve: Corrosion-resistant metal complying with ASSE 1005.

- d) Insulation: Comply with ASHRAE/IESNA 90.1. Surround entire storage tank except connections and controls.

- e) Jacket: Steel with enameled finish.

- f) Burner or Heat Exchanger: Comply with UL 795 or approved testing agency requirements for gas-fired, high-efficiency, domestic-water heaters and natural-gas fuel.

- g) Temperature Control: Adjustable thermostat.

- h) Safety Controls: Automatic, high-temperature-limit and low-water cutoff devices or systems.

- i) Combination Temperature-and-Pressure Relief Valves: ANSI Z21.22/CSA 4.4-M. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select one relief valve with sensing element that extends into storage tank.
- (5) Draft Hood: Draft diverter, complying with ANSI Z21.12.
- (6) Capacity and Characteristics:
 - a) Capacity: As Scheduled.
 - b) Recovery: As Scheduled.
 - c) Temperature Setting: As Scheduled.
 - d) Fuel Gas Input: As Scheduled.
 - e) Gas Pressure Regulator: Provided by manufacturer.
- (7) Electrical Characteristics: 120 Volts, Single phase, 60 Hertz.
- b. Domestic-Water Heater Accessories
 - (1) Domestic-Water Compression Tanks: Steel, pressure-rated tank constructed with welded joints and factory-installed butyl-rubber diaphragm. Include air precharge to minimum system-operating pressure at tank.
 - a) Construction:
 - 1. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1 pipe thread.
 - 2. Interior Finish: Comply with NSF 61 Annex G barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
 - 3. Air-Charging Valve: Factory installed.
 - b) Capacity and Characteristics:
 - 1. Working-Pressure Rating: 100 psig.
 - 2. Capacity Acceptable: As Scheduled.
 - (2) Piping-Type Heat Traps: Field-fabricated piping arrangement according to ASHRAE/IESNA 90.1 or ASHRAE 90.2.
 - (3) Comply with requirements for ball- or gate-type shutoff valves specified herein.
 - a) Comply with requirements for balancing valves specified herein.
 - (4) Gas Shutoff Valves: ANSI Z21.15/CSA 9.1-M, manually operated. Furnish for installation in piping.

- (5) Gas Pressure Regulators: ANSI Z21.18/CSA 6.3, appliance type.
- (6) Automatic Gas Valves: ANSI Z21.21/CSA 6.5, appliance, electrically operated, on-off automatic valve.
- (7) Combination Temperature-and-Pressure Relief Valves: ANSI Z21.22/CSA 4.4-M; Include relieving capacity at least as great as heat input and include pressure setting less than domestic-water heater working-pressure rating. Select relief valves with sensing element that extends into storage tank.
- (8) Pressure Relief Valves: ANSI Z21.22/CSA 4.4-M; Include pressure setting less than domestic-water heater working-pressure rating.
- (9) Vacuum Relief Valves: ANSI Z21.22/CSA 4.4-M.

c. Source Quality Control

- (1) Factory Tests: Test and inspect assembled domestic-water heaters and storage tanks specified to be ASME-code construction, according to ASME Boiler and Pressure Vessel Code.
- (2) Hydrostatically test commercial domestic-water heaters and storage tanks to minimum of one and one-half times pressure rating before shipment.
- (3) Domestic-water heaters will be considered defective if they do not pass tests and inspections.
- (4) Prepare test and inspection reports.

2.9 HOT-WATER STORAGE TANKS

Hot-water storage tanks shall be constructed by one manufacturer, ASME stamped for the working pressure, and shall have the National Board (ASME) registration. The tank shall be cement-lined or glass-lined steel type in accordance with AWWA D100. The heat loss shall conform to TABLE III in PART 3 of this Section as determined by the requirements of ASHRAE 90.1 - IP. Each tank shall be equipped with a thermometer, conforming to ASTM E1, Type I, Class 3, Range C, style and form as required for the installation, and with 7 inch scale. Thermometer shall have a separable socket suitable for a 3/4 inch tapped opening. Tanks shall be equipped with a pressure gauge 6 inch minimum diameter face. Insulation shall be as specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS. Storage tank capacity shall be as shown.

2.10 MOTORS

2.10.1 General Motor Requirements

- a. Comply with NEMA MG 1 unless otherwise indicated.
- b. Comply with IEEE 841 for severe-duty motors.

2.10.2 Motor Characteristics

- a. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.

- b. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.10.3 Polyphase Motors

- a. Description: NEMA MG 1, Design B, medium induction motor.
- b. Efficiency: Energy efficient, as defined in NEMA MG 1.
- c. Service Factor: 1.15.
- d. Multispeed Motors: Variable torque.
 - (1) For motors with 2:1 speed ratio, consequent pole, single winding.
 - (2) For motors with other than 2:1 speed ratio, separate winding for each speed.
- e. Multispeed Motors: Separate winding for each speed.
- f. Rotor: Random-wound, squirrel cage.
- g. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
- h. Temperature Rise: Match insulation rating.
- i. Insulation: Class F.
- j. Code Letter Designation:
 - (1) Motors 15 HP and Larger: NEMA starting Code F or Code G.
 - (2) Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.
- k. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.10.4 Polyphase Motors With Additional Requirements

- a. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
- b. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
 - (1) Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
 - (2) Energy- and Premium-Efficient Motors: Class B temperature rise;

Class F insulation.

- (3) Inverter-Duty Motors: Class F temperature rise; Class H insulation.
- (4) Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.
- c. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

2.10.5 Single-Phase Motors

- a. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:
 - (1) Permanent-split capacitor.
 - (2) Split phase.
 - (3) Capacitor start, inductor run.
 - (4) Capacitor start, capacitor run.
- b. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
- c. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
- d. Motors 1/20 HP and Smaller: Shaded-pole type.
- e. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

2.11 PUMPS

2.11.1 In-Line, Sealless Centrifugal Pumps

- a. Description: Factory-assembled and -tested, in-line, close-coupled, canned-motor, sealless, overhung-impeller centrifugal pumps.
- b. Pump Construction:
 - (1) Pump and Motor Assembly: Hermetically sealed, replaceable-cartridge type with motor and impeller on common shaft and designed for installation with pump and motor shaft horizontal.
 - (2) Casing: Bronze, with threaded or companion-flange connections.
 - (3) Impeller: Plastic.
 - (4) Motor: Single speed, unless otherwise indicated.
- c. Capacities and Characteristics:
 - (1) Capacity: As Scheduled.

- (2) Total Dynamic Head: As Scheduled.
- (3) Minimum Working Pressure: 125 psig.
- (4) Maximum Continuous Operating Temperature: 220 deg F.
- (5) Pump Control: Timer.
- (6) Motor Horsepower: As Scheduled.
- (7) Electrical Characteristics: Volts, 120; Single phase; 60 Hertz.

2.11.2 Horizontally Mounted, In-Line, Separately Coupled Centrifugal Pumps

- a. Description: Factory-assembled and -tested, in-line, single-stage, separately coupled, overhung-impeller centrifugal pumps designed for installation with pump and motor shafts mounted horizontal.
- b. Pump Construction:
 - (1) Casing: Radially split with threaded companion-flange connections for pumps with NPS 2 pipe connections and flanged connections for pumps with NPS 2-1/2 pipe connections.
 - (2) Impeller: Statically and dynamically balanced, closed, and keyed to shaft.
 - (3) Shaft and Shaft Sleeve: Steel shaft, with copper-alloy shaft sleeve.
 - (4) Coupling: Flexible.
 - (5) Seal: Mechanical, with carbon-steel rotating ring, stainless-steel spring, ceramic seat, and rubber bellows and gasket.
 - (6) Bearings: Oil-lubricated; bronze-journal or ball type.
 - (7) Shaft Coupling: Flexible, capable of absorbing torsional vibration and shaft misalignment.
- c. Motor: Single speed, with grease-lubricated ball bearings; and resiliently or rigidly mounted to pump casing.
- d. Capacities and Characteristics:
 - (1) Capacity: As Scheduled.
 - (2) Total Dynamic Head: As Scheduled.
 - (3) Casing Material: Cast iron.
 - (4) Impeller Material: ASTM B 584, cast bronze or stainless steel.
 - (5) Minimum Working Pressure: 125 psig.
 - (6) Maximum Continuous Operating Temperature: 225 deg F.

- (7) Pump Control: Timer.
- (8) Motor Horsepower: As Scheduled.
- (9) Electrical Characteristics: 120 Volts; Single phase; 60 Hertz.

2.11.3 HORIZONTALLY MOUNTED, IN-LINE, CLOSE-COUPLED CENTRIFUGAL PUMPS

- a. Description: Factory-assembled and -tested, in-line, single-stage, close-coupled, overhung-impeller centrifugal pumps designed for installation with pump and motor shaft mounted horizontal.
- b. Pump Construction:
 - (1) Casing: Radially split with threaded companion-flange connections for pumps with NPS 2 pipe connections and flanged connections for pumps with NPS 2-1/2 pipe connections.
 - (2) Impeller: Statically and dynamically balanced, closed, and keyed to shaft.
 - (3) Shaft and Shaft Sleeve: Steel shaft with deflector, with copper-alloy shaft sleeve. Include water slinger on shaft between motor and seal.
 - (4) Seal: Mechanical, with carbon-steel rotating ring, stainless-steel spring, ceramic seat, and rubber bellows and gasket.
 - (5) Bearings: Oil-lubricated; bronze-journal or ball type.
 - (6) Shaft Coupling: Flexible, capable of absorbing torsional vibration and shaft misalignment.
- c. Motor: Single speed, with grease-lubricated ball bearings; and resiliently or rigidly mounted to pump casing.
- d. Capacities and Characteristics:
 - (1) Capacity: As scheduled.
 - (2) Total Dynamic Head: As Scheduled.
 - (3) Casing Material: Cast iron.
 - (4) Impeller Material: ASTM B 584, cast bronze or stainless steel.
 - (5) Minimum Working Pressure: 175 psig.
 - (6) Maximum Continuous Operating Temperature: 225 deg F
 - (7) Pump Control: Timer.
 - (8) Motor Horsepower: As Scheduled.
 - (9) Electrical Characteristics: 120 Volts, Single Phase, 60 Hertz

2.11.4 Vertically Mounted, In-Line, Close-Coupled Centrifugal Pumps

- a. Description: Factory-assembled and -tested, in-line, single-stage, close-coupled, overhung-impeller centrifugal pumps designed for installation with pump and motor shaft mounted vertical.
- b. Pump Construction:
 - (1) Casing: Radially split, cast iron, with wear rings and threaded companion-flange connections for pumps with NPS 2 pipe connections and flanged connections for pumps with NPS 2-1/2 pipe connections.
 - (2) Impeller: Statically and dynamically balanced, closed, and keyed to shaft.
 - (3) Shaft and Shaft Sleeve: Stainless-steel shaft, with copper-alloy shaft sleeve.
 - (4) Seal: Mechanical, with carbon-steel rotating ring, stainless-steel spring, ceramic seat, and rubber bellows and gasket. Include water slinger on shaft between motor and seal.
 - (5) Bearings: Oil-lubricated; bronze-journal or ball type.
 - (6) Shaft Coupling: Flexible or rigid type if pump is provided with coupling.
- c. Motor: Single speed, with grease-lubricated ball bearings; rigidly mounted to pump casing.
- d. Capacities and Characteristics:
 - (1) Capacity: As Scheduled.
 - (2) Total Dynamic Head: As Scheduled.
 - (3) Casing Material: Cast iron.
 - (4) Impeller Material: ASTM B584, cast bronze or stainless steel.
 - (5). Minimum Operating Pressure: 175 psig.
 - (6) Maximum Continuous Operating Temperature: 225 deg F.
 - (7) Pump Control: Timer.
 - (8) Motor Horsepower: As Scheduled.
 - (9) Electrical Characteristics: 120 Volts, Single Phase, 60 Hertz.

2.11.5 Motors

- a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors
 - (1) Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

2.11.6 Controls

- a. Timers: Electric, for control of hot-water circulation pump.
 - (1) Type: Programmable, seven-day clock with manual override on-off switch.
 - (2) Enclosure: NEMA 250, Type 1, suitable for wall mounting.
 - (3) Operation of Pump: On or off.
 - (4) Transformer: Provide if required.
 - (5) Power Requirement: 120-V ac.
 - (6) Programmable Sequence of Operation: Up to two on-off cycles each day for seven days.

2.12 DOMESTIC WATER SERVICE METER

Cold water meters 2 inches and smaller shall be positive displacement type conforming to AWWA C700. Cold water meters 2-1/2 inches and larger shall be turbine type conforming to AWWA C701. Meter register may be round or straight reading type, indicating GPM. Meter shall be provided with a pulse generator, remote readout register and all necessary wiring and accessories.

Meters must be connected to the base wide energy and utility monitoring and control system (if this system exists) using the installation's advanced metering protocols.

2.13 ELECTRICAL WORK

Provide electrical motor driven equipment specified complete with motors, motor starters, and controls as specified herein and in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Provide internal wiring for components of packaged equipment as an integral part of the equipment. Provide high efficiency type, single-phase, fractional-horsepower alternating-current motors, including motors that are part of a system, corresponding to the applications in accordance with NEMA MG 11. Provide motors in accordance with NEMA MG 1 and of sufficient size to drive the load at the specified capacity without exceeding the nameplate rating of the motor.

Motors shall be rated for continuous duty with the enclosure specified. Motor duty requirements shall allow for maximum frequency start-stop operation and minimum encountered interval between start and stop. Motor torque shall be capable of accelerating the connected load within 20 seconds with 80 percent of the rated voltage maintained at motor terminals during one starting period. Motor bearings shall be fitted with grease supply fittings and grease relief to outside of the enclosure.

Controllers and contactors shall have auxiliary contacts for use with the controls provided. Manual or automatic control and protective or signal devices required for the operation specified and any control wiring required for controls and devices specified, but not shown, shall be provided. For packaged equipment, the manufacturer shall provide

controllers, including the required monitors and timed restart.

Power wiring and conduit for field installed equipment shall be provided under and conform to the requirements of Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

2.14 METERS AND GAGES

2.14.1 Bimetallic-Actuated Thermometers

- a. Standard: ASME B40.200.
- b. Case: Liquid-filled type(s); stainless steel with 5-inch nominal diameter.
- c. Dial: Nonreflective aluminum with permanently etched scale markings and scales in deg F.
- d. Connector Type(s): Union joint, adjustable angle, with unified-inch screw threads.
- e. Connector Size: 1/2 inch with ASME B1.1 screw threads.
- f. Stem: 0.25 or 0.375 inch in diameter; stainless steel.
- g. Window: Plain glass.
- h. Ring: Stainless steel.
- i. Element: Bimetal coil.
- j. Pointer: Dark-colored metal.
- k. Accuracy: Plus or minus 1 percent of scale range.

2.14.2 Filled-System Thermometers

- a. Direct-Mounted, Metal-Case, Vapor-Actuated Thermometers: ASME B40.200;
 - (1) Case: Sealed type, cast aluminum or drawn steel; 4-1/2-inch nominal diameter.
 - (2) Element: Bourdon tube or other type of pressure element.
 - (3) Movement: Mechanical with link to pressure element and connection to pointer.
 - (4) Dial: Nonreflective aluminum with permanently etched scale markings graduated in deg F.
 - (5) Pointer: Dark-colored metal.
 - (6) Window: Glass.
 - (7) Ring: Stainless steel.
 - (8) Connector Type(s): Union joint, adjustable, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device; with ASME B1.1 screw threads.

- (9) Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.
 - a) Design for Thermowell Installation: Bare stem.
- (10) Accuracy: Plus or minus 1 percent of scale range.
- b. Remote-Mounted, Metal-Case, Vapor-Actuated Thermometers: ASME B40.200.
 - (1) Case: Sealed type, cast aluminum or drawn steel; 4-1/2-inch nominal diameter with flange and holes for panel mounting.
 - (2) Element: Bourdon tube or other type of pressure element.
 - (3) Movement: Mechanical, with link to pressure element and connection to pointer.
 - (4) Dial: Nonreflective aluminum with permanently etched scale markings graduated in deg F.
 - (5) Pointer: Dark-colored metal.
 - (6) Window: Glass.
 - (7) Ring: Stainless steel.
 - (8) Connector Type(s): Union joint, back or bottom; with ASME B1.1 screw threads.
 - (9) Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.
 - a) Design for Thermowell Installation: Bare stem.
 - (10) Accuracy: Plus or minus 1 percent of scale range.

2.14.3 Thermowells

- a. Thermowells: ASME B40.200; Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
 - (1) Material for Use with Copper Tubing: CNR or CUNI.
 - (2) Material for Use with Steel Piping: CRES.
 - (3) Type: Stepped shank unless straight or tapered shank is indicated.
 - (4) External Threads: NPS 1/2, NPS 3/4, or NPS 1, ASME B1.20.1 pipe threads.
 - (5) Internal Threads: 1/2, 3/4, and 1 inch, with ASME B1.1 screw threads.
 - (6) Bore: Diameter required to match thermometer bulb or stem.
 - (7) Insertion Length: Length required to match thermometer bulb or stem.

(8) Lagging Extension: Include on thermowells for insulated piping and tubing.

(9) Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

b. Heat-Transfer Medium: Mixture of graphite and glycerin.

2.14.4 Pressure Gages

2.14.4.1 Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:

- a. Standard: ASME B40.100.
- b. Case: Dry or Liquid-filled type(s); cast aluminum or drawn steel; 4-1/2-inch nominal diameter.
- c. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
- d. Pressure Connection: Brass, with NPS 1/4 ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
- e. Movement: Mechanical, with link to pressure element and connection to pointer.
- f. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.
- g. Pointer: Dark-colored metal.
- h. Window: Glass.
- i. Ring: Stainless steel.
- j. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

2.14.4.2 Remote-Mounted, Metal-Case, Dial-Type Pressure Gages:

- a. Standard: ASME B40.100.
- b. Case: Dry type; cast aluminum or drawn steel; 4-1/2-inch nominal diameter with back flange and holes for panel mounting.
- c. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
- d. Pressure Connection: Brass, with NPS 1/4, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
- e. Movement: Mechanical, with link to pressure element and connection to pointer.
- f. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.
- g. Pointer: Dark-colored metal.
- h. Window: Glass.

- i. Ring: Stainless steel.
- j. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

2.14.5 Gage Attachments

- a. Snubbers: ASME B40.100, brass; with NPS 1/4, ASME B1.20.1 pipe threads and porous-metal-type surge-dampening device. Include extension for use on insulated piping.
- b. Valves: Brass or stainless-steel needle, with NPS 1/4 , ASME B1.20.1 pipe threads.

2.14.6 Test Plugs

- a. Description: Test-station fitting made for insertion into piping tee fitting.
- b. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.
- c. Thread Size: NPS 1/4, ASME B1.20.1 pipe thread.
- d. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.
- e. Core Inserts: Chlorosulfonated polyethylene synthetic and EPDM self-sealing rubber.

2.14.7 Test-Plug Kits

- a. Furnish one test-plug kit(s) containing two thermometer(s), one pressure gage and adapter, and carrying case. Thermometer sensing elements, pressure gage, and adapter probes shall be of diameter to fit test plugs and of length to project into piping.
- b. Low-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch-diameter dial and tapered-end sensing element. Dial range shall be at least 25 to 125 deg F.
- c. High-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch-diameter dial and tapered-end sensing element. Dial range shall be at least 0 to 220 deg F.
- d. Pressure Gage: Small, Bourdon-tube insertion type with 2- to 3-inch-diameter dial and probe. Dial range shall be at least 0 to 200 psig.
- e. Carrying Case: Metal or plastic, with formed instrument padding.

2.14.8 Sight Flow Indicators

- a. Description: Piping inline-installation device for visual verification of flow.
- b. Construction: Bronze or stainless-steel body, with sight glass and ball, flapper, or paddle wheel indicator, and threaded or flanged ends.

- c. Minimum Pressure Rating: 150 psig.
- d. Minimum Temperature Rating: 200 deg F.
- e. End Connections for NPS 2 and Smaller: Threaded.
- f. End Connections for NPS 2-1/2 and Larger: Flanged.

2.14.9 Meter and Gages Schedule

2.14.9.1 Thermometer Schedule

- a. Thermometers at inlet and outlet of each domestic water heater shall be one of the following:
 - (1) Liquid-filled bimetallic-actuated type.
 - (2) Direct-mounted, metal case, vapor-actuated type.
- b. Thermometers at inlets and outlets of each domestic water heat exchanger shall be one of the following:
 - (1) Liquid-filled bimetallic-actuated type.
 - (2) Direct-mounted, metal-case, vapor-actuated type.
- c. Thermometers at inlet and outlet of each domestic hot-water storage tank shall be one of the following:
 - (1) Liquid-filled, bimetallic-actuated type.
 - (2) Direct-mounted, metal-case, vapor-actuated type.
- d. Thermometers at inlet of each hot water recirculation pump shall be one of the following:
 - (1) Liquid-filled, bimetallic-actuated type.
 - (2) Direct-mounted, metal-case, vapor-actuated type.
- e. Thermometer stems shall be of length to match thermowell insertion length.

2.14.9.2 Thermometer Scale-Range Schedule

- a. Scale Range for Domestic Cold-Water Piping: 0 to 100 deg F .
- b. Scale Range for Domestic Hot-and hot water recirculation Water Piping: 30 to 180 deg F

2.14.9.3 Pressure-Gage Schedule

- a. Pressure gages at discharge of each water service into building shall be the following:
 - (1) Dry type or Liquid-filled direct-mounted, metal case.
- b. Pressure gages at inlet and outlet of each water pressure-reducing valve shall be the following:

(1) Dry type or liquid-filled direct-mounted, metal case.

- c. Pressure gages at suction and discharge of each domestic water booster pump shall be the following:

(1) Dry type or Liquid-filled, direct-mounted, metal case.

2.14.9.4 Pressure-Gage Scale-Range Schedule

- a. Scale Range for Water Service Piping: 0 to 160 psi.

2.15 MISCELLANEOUS PIPING ITEMS

2.15.1 Escutcheon Plates

Provide one piece or split hinge metal plates for piping entering floors, walls, and ceilings in exposed spaces as indicated below. Provide chromium-plated on copper alloy plates or polished stainless steel finish in finished spaces. Provide paint finish on plates in unfinished spaces.

2.15.1.1 Escutcheons

- a. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener
- b. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.
- c. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.
- d. Split-Casting Brass Type: With polished, chrome-plated finish and with concealed hinge and setscrew.
- e. Split-Plate, Stamped-Steel Type: With chrome-plated finish, concealed and exposed-rivet hinge, and spring-clip fasteners.

2.15.1.2 Floor Plates

- a. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.
- b. Split-Casting Floor Plates: Cast brass with concealed hinge.

2.15.2 Pipe Sleeves

Provide where piping passes entirely through walls, ceilings, roofs, and floors. Sleeves are not required where supply, drain, waste, and vent (DWV) piping passes through concrete floor slabs located on grade, except where penetrating a membrane waterproof floor.

- a. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
- b. Galvanized-Steel Wall Pipes: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.
- c. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B,

Schedule 40, zinc coated, with plain ends.

- d. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.
- e. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
- f. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.
- g. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.

2.15.2.1 STACK-SLEEVE FITTINGS

- a. Description: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring, bolts, and nuts for membrane flashing.
 - (1) Underdeck Clamp: Clamping ring with setscrews.

2.15.2.2 SLEEVE-SEAL SYSTEMS

- a. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
 - (1) Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 - (2) Pressure Plates: Carbon steel.
 - (3) Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

2.15.2.3 SLEEVE-SEAL FITTINGS

- a. Description: Manufactured plastic, sleeve-type, waterstop assembly made for imbedding in concrete slab or wall. Unit has plastic or rubber waterstop collar with center opening to match piping OD.

2.15.2.4 GROUT

- a. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- b. Characteristics: Nonshrink; recommended for interior and exterior applications.
- c. Design Mix: 5000-psi, 28-day compressive strength.
- d. Packaging: Premixed and factory packaged.

2.15.2.5 Sleeves in Masonry and Concrete

Provide steel pipe sleeves or schedule 40 PVC plastic pipe sleeves. Sleeves are not required where drain, waste, and vent (DWV) piping passes through concrete floor slabs located on grade. Core drilling of masonry and concrete may be provided in lieu of pipe sleeves when cavities in the core-drilled hole are completely grouted smooth.

2.15.2.6 Sleeves Not in Masonry and Concrete

Provide 26 gage galvanized steel sheet or PVC plastic pipe sleeves.

2.15.3 Pipe Hangers (Supports)

Provide **MSS SP-58** Type 1 with adjustable type steel support rods, except as specified or indicated otherwise. Attach to steel joists with Type 19 or 23 clamps and retaining straps. Attach to Steel W or S beams with Type 21, 28, 29, or 30 clamps. Attach to steel angles and vertical web steel channels with Type 20 clamp with beam clamp channel adapter. Attach to horizontal web steel channel and wood with drilled hole on centerline and double nut and washer. Attach to concrete with Type 18 insert or drilled expansion anchor. Provide Type 40 insulation protection shield for insulated piping.

2.15.4 Equipment and Pipe Identification

2.15.4.1 EQUIPMENT LABELS

a. Metal Labels for Equipment:

- (1) Material and Thickness: aluminum, 0.032-inch or anodized aluminum, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
- (2) Color: White letters; Black background.
- (3) Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- (4) Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
- (5) Fasteners: Stainless-steel rivets or self-tapping screws.
- (6) Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

b. Plastic Labels for Equipment:

- (1) Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
- (2) Color: White letters; Black background.
- (3) Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- (4) Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- (5) Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up

to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.

- (6) Fasteners: Stainless-steel rivets or self-tapping screws.
- (7) Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- c. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.
- d. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number, and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.15.4.2 PIPE LABELS

- a. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
- b. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
- c. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; also include pipe size and an arrow indicating flow direction.
 - (1) Flow-Direction Arrows: Integral with piping-system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
 - (2) Lettering Size: Size letters according to ASME A13.1 for piping.
- d. Pipe Label Color Schedule:
 - (1) Domestic Water Piping
 - a) Background: Safety green.
 - b) Letter Colors: White.
 - (2) Natural Gas Piping
 - a) Background: Yellow.
 - b) Letter Colors: Black.

2.15.4.3 VALVE TAGS

- a. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.

(1) Tag Material: Brass, 0.032-inch or stainless steel, 0.025-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.

(2) Fasteners: Brass wire-link chain, beaded chain or S-hook.

b. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

(1) Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:

a) Valve-Tag Size and Shape: Hot and cold water - 2 inches round.

b) Valve-Tag Colors: Hot and Cold Water - Natural.

c) Letter Colors: Hot and Cold Water - Black.

(2) Valve-tag schedule shall be included in operation and maintenance data.

2.15.5 Labels

Provide labels for sensor operators at flush valves and faucets. Include the following information on each label:

- a. Identification of the sensor and its operation with written description.
- b. Range of the sensor.
- c. Battery replacement schedule.

PART 3 EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

Piping located in air plenums shall conform to NFPA 90A requirements. Piping located in shafts that constitute air ducts or that enclose air ducts shall be noncombustible in accordance with NFPA 90A. Installation of plastic pipe where in compliance with NFPA may be installed in accordance with PPFA Fire Man. The plumbing system shall be installed complete with necessary fixtures, fittings, traps, valves, and accessories. Water and drainage piping shall be extended 5 feet outside the building, unless otherwise indicated. A ball valve and drain shall be installed on the water service line inside the building approximately 6 inches above the floor from point of entry. Piping shall be connected to the exterior service lines or capped or plugged if the exterior service is not in place. Sewer and water pipes shall be laid in separate trenches, except when otherwise shown. Exterior underground utilities shall be at least 12 inches below the finish grade or as indicated on the drawings. If trenches are closed or the pipes are otherwise covered before being connected to the service lines, the location of the end of each plumbing

utility shall be marked with a stake or other acceptable means. Valves shall be installed with control no lower than the valve body.

3.1.1 Water Pipe, Fittings, and Connections

3.1.1.1 Utilities

The piping shall be extended to fixtures, outlets, and equipment. The hot-water and cold-water piping system shall be arranged and installed to permit draining. The supply line to each item of equipment or fixture, except faucets, flush valves, or other control valves which are supplied with integral stops, shall be equipped with a shutoff valve to enable isolation of the item for repair and maintenance without interfering with operation of other equipment or fixtures. Supply piping to fixtures, faucets, hydrants, shower heads, and flushing devices shall be anchored to prevent movement.

3.1.1.2 Cutting and Repairing

The work shall be carefully laid out in advance, and unnecessary cutting of construction shall be avoided. Damage to building, piping, wiring, or equipment as a result of cutting shall be repaired by mechanics skilled in the trade involved.

3.1.1.3 Protection of Fixtures, Materials, and Equipment

Pipe openings shall be closed with caps or plugs during installation. Fixtures and equipment shall be tightly covered and protected against dirt, water, chemicals, and mechanical injury. Upon completion of the work, the fixtures, materials, and equipment shall be thoroughly cleaned, adjusted, and operated. Safety guards shall be provided for exposed rotating equipment.

3.1.1.4 Mains, Branches, and Runouts

Piping shall be installed as indicated. Pipe shall be accurately cut and worked into place without springing or forcing. Structural portions of the building shall not be weakened. Aboveground piping shall run parallel with the lines of the building, unless otherwise indicated. Branch pipes from service lines may be taken from top, bottom, or side of main, using crossover fittings required by structural or installation conditions. Supply pipes, valves, and fittings shall be kept a sufficient distance from other work and other services to permit not less than 1/2 inch between finished covering on the different services. Bare and insulated water lines shall not bear directly against building structural elements so as to transmit sound to the structure or to prevent flexible movement of the lines. Water pipe shall not be buried in or under floors unless specifically indicated or approved. Changes in pipe sizes shall be made with reducing fittings. Use of bushings will not be permitted except for use in situations in which standard factory fabricated components are furnished to accommodate specific accepted installation practice. Change in direction shall be made with fittings, except that bending of pipe 4 inches and smaller will be permitted, provided a pipe bender is used and wide sweep bends are formed. The center-line radius of bends shall be not less than six diameters of the pipe. Bent pipe showing kinks, wrinkles, flattening, or other malformations will not be acceptable.

3.1.1.5 Pipe Drains

Pipe drains indicated shall consist of 3/4 inch hose bibb with renewable seat and ball valve ahead of hose bibb. At other low points, 3/4 inch brass plugs or caps shall be provided. Disconnection of the supply piping at the fixture is an acceptable drain.

3.1.1.6 Expansion and Contraction of Piping

Allowance shall be made throughout for expansion and contraction of water pipe. Each hot-water and hot-water circulation riser shall have expansion loops or other provisions such as offsets and changes in direction where indicated and required. Risers shall be securely anchored as required or where indicated to force expansion to loops. Branch connections from risers shall be made with ample swing or offset to avoid undue strain on fittings or short pipe lengths. Horizontal runs of pipe over 50 feet in length shall be anchored to the wall or the supporting construction about midway on the run to force expansion, evenly divided, toward the ends. Sufficient flexibility shall be provided on branch runouts from mains and risers to provide for expansion and contraction of piping. Flexibility shall be provided by installing one or more turns in the line so that piping will spring enough to allow for expansion without straining. If mechanical grooved pipe coupling systems are provided, the deviation from design requirements for expansion and contraction may be allowed pending approval of Contracting Officer.

3.1.1.7 Thrust Restraint

Plugs, caps, tees, valves and bends deflecting 11.25 degrees or more, either vertically or horizontally, in waterlines 4 inches in diameter or larger shall be provided with thrust blocks, where indicated, to prevent movement. Thrust blocking shall be concrete of a mix not leaner than: 1 cement, 2-1/2 sand, 5 gravel; and having a compressive strength of not less than 2000 psi after 28 days. Blocking shall be placed between solid ground and the fitting to be anchored. Unless otherwise indicated or directed, the base and thrust bearing sides of the thrust block shall be poured against undisturbed earth. The side of the thrust block not subject to thrust shall be poured against forms. The area of bearing will be as shown. Blocking shall be placed so that the joints of the fitting are accessible for repair. Steel rods and clamps, protected by galvanizing or by coating with bituminous paint, shall be used to anchor vertical down bends into gravity thrust blocks.

3.1.1.8 Commercial-Type Water Hammer Arresters

Commercial-type water hammer arresters shall be provided on hot- and cold-water supplies and shall be located as generally indicated, with precise location and sizing to be in accordance with PDI WH 201. Water hammer arresters, where concealed, shall be accessible by means of access doors or removable panels. Commercial-type water hammer arresters shall conform to ASSE 1010. Vertical capped pipe columns will not be permitted.

3.1.2 Joints

Installation of pipe and fittings shall be made in accordance with the manufacturer's recommendations. Mitering of joints for elbows and notching of straight runs of pipe for tees will not be permitted. Joints shall be made up with fittings of compatible material and made for the specific purpose intended.

3.1.2.1 Threaded

Threaded joints shall have American Standard taper pipe threads conforming to ASME B1.20.1. Only male pipe threads shall be coated with graphite or with an approved graphite compound, or with an inert filler and oil, or shall have a polytetrafluoroethylene tape applied.

3.1.2.2 Mechanical Couplings

Mechanical couplings may be used in conjunction with grooved pipe for aboveground, ferrous or non-ferrous, domestic hot and cold water systems, in lieu of unions, brazed, soldered, welded, flanged, or threaded joints.

Mechanical couplings are permitted in accessible locations including behind access plates. Flexible grooved joints will not be permitted, except as vibration isolators adjacent to mechanical equipment. Rigid grooved joints shall incorporate an angle bolt pad design which maintains metal-to-metal contact with equal amount of pad offset of housings upon installation to ensure positive rigid clamping of the pipe.

Designs which can only clamp on the bottom of the groove or which utilize gripping teeth or jaws, or which use misaligned housing bolt holes, or which require a torque wrench or torque specifications will not be permitted.

Grooved fittings and couplings, and grooving tools shall be provided from the same manufacturer. Segmentally welded elbows shall not be used. Grooves shall be prepared in accordance with the coupling manufacturer's latest published standards. Grooving shall be performed by qualified grooving operators having demonstrated proper grooving procedures in accordance with the tool manufacturer's recommendations.

The Contracting Officer shall be notified 24 hours in advance of test to demonstrate operator's capability, and the test shall be performed at the work site, if practical, or at a site agreed upon. The operator shall demonstrate the ability to properly adjust the grooving tool, groove the pipe, and to verify the groove dimensions in accordance with the coupling manufacturer's specifications.

3.1.2.3 Unions and Flanges

Unions, flanges and mechanical couplings shall not be concealed in walls, ceilings, or partitions. Unions shall be used on pipe sizes 2-1/2 inches and smaller; flanges shall be used on pipe sizes 3 inches and larger.

3.1.2.4 Grooved Mechanical Joints

Grooves shall be prepared according to the coupling manufacturer's instructions. Grooved fittings, couplings, and grooving tools shall be products of the same manufacturer. Pipe and groove dimensions shall comply with the tolerances specified by the coupling manufacturer. The diameter of grooves made in the field shall be measured using a "go/no-go" gauge, vernier or dial caliper, narrow-land micrometer, or other method specifically approved by the coupling manufacturer for the intended application. Groove width and dimension of groove from end of pipe shall be measured and recorded for each change in grooving tool setup to verify compliance with coupling manufacturer's tolerances. Grooved joints shall not be used in concealed locations.

3.1.2.5 Cast Iron Soil, Waste and Vent Pipe

Bell and spigot compression and hubless gasketed clamp joints for soil, waste and vent piping shall be installed per the manufacturer's recommendations.

3.1.2.6 Copper Tube and Pipe

- a. Brazed. Brazed joints shall be made in conformance with AWS B2.2/B2.2M, ASME B16.50, and CDA A4015 with flux and are acceptable for all pipe sizes. Copper to copper joints shall include the use of copper-phosphorus or copper-phosphorus-silver brazing metal without flux. Brazing of dissimilar metals (copper to bronze or brass) shall include the use of flux with either a copper-phosphorus, copper-phosphorus-silver or a silver brazing filler metal.
- b. Soldered. Soldered joints shall be made with flux and are only acceptable for piping 2 inches and smaller. Soldered joints shall conform to ASME B31.5 and CDA A4015. Soldered joints shall not be used in compressed air piping between the air compressor and the receiver.
- c. Copper Tube Extracted Joint. Mechanically extracted joints shall be made in accordance with ICC IPC.
- d. Press connection. Copper press connections shall be made in strict accordance with the manufacturer's installation instructions for manufactured rated size. The joints shall be pressed using the tool(s) approved by the manufacturer of that joint. Minimum distance between fittings shall be in accordance with the manufacturer's requirements.

3.1.2.7 Corrosive Waste Plastic Pipe

Joints for polyolefin pipe and fittings shall be made by mechanical joint or electrical fusion coil method in accordance with ASTM D2657 and ASTM F1290. Joints for filament-wound reinforced thermosetting resin pipe shall be made in accordance with manufacturer's instructions. Unions or flanges shall be used where required for disconnection and inspection.

3.1.2.8 Polypropylene Pipe

Joints for polypropylene pipe and fittings shall be made by heat fusion welding socket-type or butt-fusion type fittings and shall comply with ASTM F2389.

3.1.2.9 Other Joint Methods

3.1.3 Dissimilar Pipe Materials

Connections between ferrous and non-ferrous copper water pipe shall be made with dielectric unions or flange waterways. Dielectric waterways shall have temperature and pressure rating equal to or greater than that specified for the connecting piping. Waterways shall have metal connections on both ends suited to match connecting piping. Dielectric waterways shall be internally lined with an insulator specifically designed to prevent current flow between dissimilar metals. Dielectric flanges shall meet the performance requirements described herein for

dielectric waterways. Connecting joints between plastic and metallic pipe shall be made with transition fitting for the specific purpose.

3.1.4 Corrosion Protection for Buried Pipe and Fittings

Ductile iron, cast iron, and steel pipe, fittings, and joints shall have a protective coating. Additionally, ductile iron, cast iron, and steel pressure pipe shall have a cathodic protection system and joint bonding. Coatings shall be selected, applied, and inspected in accordance with [NACE SP0169](#) and as otherwise specified. The pipe shall be cleaned and the coating system applied prior to pipe tightness testing. Joints and fittings shall be cleaned and the coating system applied after pipe tightness testing. For tape coating systems, the tape shall conform to [AWWA C203](#) and shall be applied with a 50 percent overlap. Primer utilized with tape type coating systems shall be as recommended by the tape manufacturer.

3.1.5 Pipe Sleeves and Flashing

Pipe sleeves shall be furnished and set in their proper and permanent location.

3.1.5.1 Sleeve Requirements

Unless indicated otherwise, provide pipe sleeves meeting the following requirements:

- a. Secure sleeves in position and location during construction. Provide sleeves of sufficient length to pass through entire thickness of walls, ceilings, roofs, and floors.
- b. A modular mechanical type sealing assembly may be installed in lieu of a waterproofing clamping flange and caulking and sealing of annular space between pipe and sleeve. The seals shall consist of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe and sleeve using galvanized steel bolts, nuts, and pressure plates. The links shall be loosely assembled with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and each nut. After the seal assembly is properly positioned in the sleeve, tightening of the bolt shall cause the rubber sealing elements to expand and provide a watertight seal between the pipe and the sleeve. Each seal assembly shall be sized as recommended by the manufacturer to fit the pipe and sleeve involved.
- c. Sleeves shall not be installed in structural members, except where indicated or approved. Rectangular and square openings shall be as detailed. Each sleeve shall extend through its respective floor, or roof, and shall be cut flush with each surface, except for special circumstances. Pipe sleeves passing through floors in wet areas such as mechanical equipment rooms, lavatories, kitchens, and other plumbing fixture areas shall extend a minimum of [4 inches](#) above the finished floor.
- d. Unless otherwise indicated, sleeves shall be of a size to provide a minimum of [1/4 inch](#) clearance between bare pipe or insulation and inside of sleeve or between insulation and inside of sleeve. Sleeves in bearing walls and concrete slab on grade floors shall be steel pipe or cast-iron pipe. Sleeves in nonbearing walls or ceilings may be

steel pipe, cast-iron pipe, galvanized sheet metal with lock-type longitudinal seam, or plastic.

- e. Except as otherwise specified, the annular space between pipe and sleeve, or between jacket over insulation and sleeve, shall be sealed as indicated with sealants conforming to **ASTM C920** and with a primer, backstop material and surface preparation as specified in Section **07 92 00 JOINT SEALANTS**. The annular space between pipe and sleeve, between bare insulation and sleeve or between jacket over insulation and sleeve shall not be sealed for interior walls which are not designated as fire rated.
- f. Sleeves through below-grade walls in contact with earth shall be recessed **1/2 inch** from wall surfaces on both sides. Annular space between pipe and sleeve shall be filled with backing material and sealants in the joint between the pipe and wall as specified above. Sealant selected for the earth side of the wall shall be compatible with dampproofing/waterproofing materials that are to be applied over the joint sealant. Pipe sleeves in fire-rated walls shall conform to the requirements in Section **07 84 00 FIRESTOPPING**.

3.1.5.2 Flashing Requirements

Pipes passing through roof shall be installed through a **16 ounce** copper flashing, each within an integral skirt or flange. Flashing shall be suitably formed, and the skirt or flange shall extend not less than **8 inches** from the pipe and shall be set over the roof or floor membrane in a solid coating of bituminous cement. The flashing shall extend up the pipe a minimum of **10 inches**. For cleanouts, the flashing shall be turned down into the hub and caulked after placing the ferrule. Pipes passing through pitched roofs shall be flashed, using lead or copper flashing, with an adjustable integral flange of adequate size to extend not less than **8 inches** from the pipe in all directions and lapped into the roofing to provide a watertight seal. The annular space between the flashing and the bare pipe or between the flashing and the metal-jacket-covered insulation shall be sealed as indicated. Flashing for dry vents shall be turned down into the pipe to form a waterproof joint. Pipes, up to and including **10 inches** in diameter, passing through roof or floor waterproofing membrane may be installed through a cast-iron sleeve with caulking recess, anchor lugs, flashing-clamp device, and pressure ring with brass bolts. Flashing shield shall be fitted into the sleeve clamping device. Pipes passing through wall waterproofing membrane shall be sleeved as described above. A waterproofing clamping flange shall be installed.

3.1.5.3 Waterproofing

Waterproofing at floor-mounted water closets shall be accomplished by forming a flashing guard from soft-tempered sheet copper. The center of the sheet shall be perforated and turned down approximately **1-1/2 inches** to fit between the outside diameter of the drainpipe and the inside diameter of the cast-iron or steel pipe sleeve. The turned-down portion of the flashing guard shall be embedded in sealant to a depth of approximately **1-1/2 inches**; then the sealant shall be finished off flush to floor level between the flashing guard and drainpipe. The flashing guard of sheet copper shall extend not less than **8 inches** from the drainpipe and shall be lapped between the floor membrane in a solid coating of bituminous cement. If cast-iron water closet floor flanges are used, the space between the pipe sleeve and drainpipe shall be sealed with sealant and the flashing guard shall be upturned approximately **1-1/2 inches**

to fit the outside diameter of the drainpipe and the inside diameter of the water closet floor flange. The upturned portion of the sheet fitted into the floor flange shall be sealed.

3.1.5.4 Optional Counterflashing

Instead of turning the flashing down into a dry vent pipe, or caulking and sealing the annular space between the pipe and flashing or metal-jacket-covered insulation and flashing, counterflashing may be accomplished by utilizing the following:

- a. A standard roof coupling for threaded pipe up to 6 inches in diameter.
- b. A tack-welded or banded-metal rain shield around the pipe.

3.1.5.5 Pipe Penetrations of Slab on Grade Floors

Where pipes, fixture drains, floor drains, cleanouts or similar items penetrate slab on grade floors, except at penetrations of floors with waterproofing membrane as specified in paragraphs FLASHING REQUIREMENTS and WATERPROOFING, a groove 1/4 to 1/2 inch wide by 1/4 to 3/8 inch deep shall be formed around the pipe, fitting or drain. The groove shall be filled with a sealant as specified in Section 07 92 00 JOINT SEALANTS.

3.1.5.6 Pipe Penetrations

Provide sealants for all pipe penetrations. All pipe penetrations shall be sealed to prevent infiltration of air, insects, and vermin.

3.1.6 Fire Seal

Where pipes pass through fire walls, fire-partitions, fire-rated pipe chase walls or floors above grade, a fire seal shall be provided as specified in Section 07 84 00 FIRESTOPPING.

3.1.7 Supports

3.1.7.1 General

Hangers used to support piping 2 inches and larger shall be fabricated to permit adequate adjustment after erection while still supporting the load. Pipe guides and anchors shall be installed to keep pipes in accurate alignment, to direct the expansion movement, and to prevent buckling, swaying, and undue strain. Piping subjected to vertical movement when operating temperatures exceed ambient temperatures shall be supported by variable spring hangers and supports or by constant support hangers. In the support of multiple pipe runs on a common base member, a clip or clamp shall be used where each pipe crosses the base support member. Spacing of the base support members shall not exceed the hanger and support spacing required for an individual pipe in the multiple pipe run. Threaded sections of rods shall not be formed or bent.

3.1.7.2 Pipe Supports and Structural Bracing, Seismic Requirements

Piping and attached valves shall be supported and braced to resist seismic loads as shown. Structural steel required for reinforcement to properly support piping, headers, and equipment, but not shown, shall be provided. Material used for supports shall be as specified in Section 05 50 13 MISCELLANEOUS METAL FABRICATIONS.

3.1.7.3 Pipe Hangers, Inserts, and Supports

Installation of pipe hangers, inserts and supports shall conform to **MSS SP-58** except as modified herein.

- a. Types 5, 12, and 26 shall not be used.
- b. Type 3 shall not be used on insulated pipe.
- c. Type 18 inserts shall be secured to concrete forms before concrete is placed. Continuous inserts which allow more adjustment may be used if they otherwise meet the requirements for type 18 inserts.
- d. Type 19 and 23 C-clamps shall be torqued per **MSS SP-58** and shall have both locknuts and retaining devices furnished by the manufacturer. Field-fabricated C-clamp bodies or retaining devices are not acceptable.
- e. Type 20 attachments used on angles and channels shall be furnished with an added malleable-iron heel plate or adapter.
- f. Type 24 may be used only on trapeze hanger systems or on fabricated frames.
- g. Type 39 saddles shall be used on insulated pipe **4 inches** and larger when the temperature of the medium is **60 degrees F** or higher. Type 39 saddles shall be welded to the pipe.
- h. Type 40 shields shall:
 - (1) Be used on insulated pipe less than **4 inches**.
 - (2) Be used on insulated pipe **4 inches** and larger when the temperature of the medium is **60 degrees F** or less.
 - (3) Have a high density insert for all pipe sizes. High density inserts shall have a density of **8 pcf** or greater.
- i. Horizontal pipe supports shall be spaced as specified in **MSS SP-58** and a support shall be installed not over **1 foot** from the pipe fitting joint at each change in direction of the piping. Pipe supports shall be spaced not over **5 feet** apart at valves. Operating temperatures in determining hanger spacing for PVC or CPVC pipe shall be **120 degrees F** for PVC and **180 degrees F** for CPVC. Horizontal pipe runs shall include allowances for expansion and contraction.
- j. Vertical pipe shall be supported at each floor, except at slab-on-grade, at intervals of not more than **15 feet** nor more than **8 feet** from end of risers, and at vent terminations. Vertical pipe risers shall include allowances for expansion and contraction.
- k. Type 35 guides using steel, reinforced polytetrafluoroethylene (PTFE) or graphite slides shall be provided to allow longitudinal pipe movement. Slide materials shall be suitable for the system operating temperatures, atmospheric conditions, and bearing loads encountered. Lateral restraints shall be provided as needed. Where steel slides do not require provisions for lateral restraint the following may be used:

- (1) On pipe 4 inches and larger when the temperature of the medium is 60 degrees F or higher, a Type 39 saddle, welded to the pipe, may freely rest on a steel plate.
 - (2) On pipe less than 4 inches a Type 40 shield, attached to the pipe or insulation, may freely rest on a steel plate.
 - (3) On pipe 4 inches and larger carrying medium less than 60 degrees F a Type 40 shield, attached to the pipe or insulation, may freely rest on a steel plate.
- l. Pipe hangers on horizontal insulated pipe shall be the size of the outside diameter of the insulation. The insulation shall be continuous through the hanger on all pipe sizes and applications.
 - m. Where there are high system temperatures and welding to piping is not desirable, the type 35 guide shall include a pipe cradle, welded to the guide structure and strapped securely to the pipe. The pipe shall be separated from the slide material by at least 4 inches or by an amount adequate for the insulation, whichever is greater.
 - n. Hangers and supports for plastic pipe shall not compress, distort, cut or abrade the piping, and shall allow free movement of pipe except where otherwise required in the control of expansion/contraction.

3.1.7.4 Structural Attachments

Attachment to building structure concrete and masonry shall be by cast-in concrete inserts, built-in anchors, or masonry anchor devices. Inserts and anchors shall be applied with a safety factor not less than 5. Supports shall not be attached to metal decking. Supports shall not be attached to the underside of concrete filled floor or concrete roof decks unless approved by the Contracting Officer. Masonry anchors for overhead applications shall be constructed of ferrous materials only.

3.1.8 Welded Installation

Plumbing pipe weldments shall be as indicated. Changes in direction of piping shall be made with welding fittings only; mitering or notching pipe to form elbows and tees or other similar type construction will not be permitted. Branch connection may be made with either welding tees or forged branch outlet fittings. Branch outlet fittings shall be forged, flared for improvement of flow where attached to the run, and reinforced against external strains. Beveling, alignment, heat treatment, and inspection of weld shall conform to ASME B31.1. Weld defects shall be removed and repairs made to the weld, or the weld joints shall be entirely removed and rewelded. After filler metal has been removed from its original package, it shall be protected or stored so that its characteristics or welding properties are not affected. Electrodes that have been wetted or that have lost any of their coating shall not be used.

3.1.9 Pipe Cleanouts

Pipe cleanouts shall be the same size as the pipe except that cleanout plugs larger than 4 inches will not be required. A cleanout installed in connection with cast-iron soil pipe shall consist of a long-sweep 1/4 bend or one or two 1/8 bends extended to the place shown. An extra-heavy cast-brass or cast-iron ferrule with countersunk cast-brass head screw plug shall be caulked into the hub of the fitting and shall be flush with

the floor. Cleanouts in connection with other pipe, where indicated, shall be T-pattern, 90-degree branch drainage fittings with cast-brass screw plugs, except plastic plugs shall be installed in plastic pipe. Plugs shall be the same size as the pipe up to and including 4 inches. Cleanout tee branches with screw plug shall be installed at the foot of soil and waste stacks, at the foot of interior downspouts, on each connection to building storm drain where interior downspouts are indicated, and on each building drain outside the building. Cleanout tee branches may be omitted on stacks in single story buildings with slab-on-grade construction or where less than 18 inches of crawl space is provided under the floor. Cleanouts on pipe concealed in partitions shall be provided with chromium plated bronze, nickel bronze, nickel brass or stainless steel flush type access cover plates. Round access covers shall be provided and secured to plugs with securing screw. Square access covers may be provided with matching frames, anchoring lugs and cover screws. Cleanouts in finished walls shall have access covers and frames installed flush with the finished wall. Cleanouts installed in finished floors subject to foot traffic shall be provided with a chrome-plated cast brass, nickel brass, or nickel bronze cover secured to the plug or cover frame and set flush with the finished floor. Heads of fastening screws shall not project above the cover surface. Where cleanouts are provided with adjustable heads, the heads shall be cast iron .

3.2 WATER HEATERS AND HOT WATER STORAGE TANKS

3.2.1 Relief Valves

No valves shall be installed between a relief valve and its water heater or storage tank. The P&T relief valve shall be installed where the valve actuator comes in contact with the hottest water in the heater. Whenever possible, the relief valve shall be installed directly in a tapping in the tank or heater; otherwise, the P&T valve shall be installed in the hot-water outlet piping. A vacuum relief valve shall be provided on the cold water supply line to the hot-water storage tank or water heater and mounted above and within 6 inches above the top of the tank or water heater.

3.2.2 Installation of Gas- Fired Water Heater

Installation shall conform to NFPA 54 for gas fired. Storage water heaters that are not equipped with integral heat traps and having vertical pipe risers shall be installed with heat traps directly on both the inlet and outlet. Circulating systems need not have heat traps installed. An acceptable heat trap may be a piping arrangement such as elbows connected so that the inlet and outlet piping make vertically upward runs of not less than 24 inches just before turning downward or directly horizontal into the water heater's inlet and outlet fittings. Commercially available heat traps, specifically designed by the manufacturer for the purpose of effectively restricting the natural tendency of hot water to rise through vertical inlet and outlet piping during standby periods may also be approved.

3.2.3 Heat Traps

Piping to and from each water heater and hot water storage tank shall be routed horizontally and downward a minimum of 2 feet before turning in an upward direction.

3.2.4 Connections to Water Heaters

Connections of metallic pipe to water heaters shall be made with dielectric unions or flanges.

3.2.5 Expansion Tank

A pre-charged expansion tank shall be installed on the cold water supply between the water heater inlet and the cold water supply shut-off valve. The Contractor shall adjust the expansion tank air pressure, as recommended by the tank manufacturer, to match incoming water pressure.

3.3 FIXTURES AND FIXTURE TRIMMINGS

Polished chromium-plated pipe, valves, and fittings shall be provided where exposed to view. Angle stops, straight stops, stops integral with the faucets, or concealed type of lock-shield, and loose-key pattern stops for supplies with threaded, sweat or solvent weld inlets shall be furnished and installed with fixtures. Where connections between copper tubing and faucets are made by rubber compression fittings, a beading tool shall be used to mechanically deform the tubing above the compression fitting. Exposed traps and supply pipes for fixtures and equipment shall be connected to the rough piping systems at the wall, unless otherwise specified under the item. Floor and wall escutcheons shall be as specified. Drain lines and hot water lines of fixtures for handicapped personnel shall be insulated and do not require polished chrome finish. Plumbing fixtures and accessories shall be installed within the space shown.

3.3.1 Fixture Connections

Where space limitations prohibit standard fittings in conjunction with the cast-iron floor flange, special short-radius fittings shall be provided. Connections between earthenware fixtures and flanges on soil pipe shall be made gastight and watertight with a closet-setting compound or neoprene gasket and seal. Use of natural rubber gaskets or putty will not be permitted. Fixtures with outlet flanges shall be set the proper distance from floor or wall to make a first-class joint with the closet-setting compound or gasket and fixture used.

3.3.2 Flushometer Valves

Flushometer valves shall be secured to prevent movement by anchoring the long finished top spud connecting tube to wall adjacent to valve with approved metal bracket. Flushometer valves for water closets shall be installed **39 inches** above the floor, except at water closets intended for use by the physically handicapped where flushometer valves shall be mounted at approximately **30 inches** above the floor and arranged to avoid interference with grab bars. In addition, for water closets intended for handicap use, the flush valve handle shall be installed on the wide side of the enclosure.

3.3.3 Height of Fixture Rims Above Floor

Lavatories shall be mounted with rim **31 inches** above finished floor. Wall-hung drinking fountains and water coolers shall be installed with rim **42 inches** above floor. Wall-hung service sinks shall be mounted with rim **28 inches** above the floor. Installation of fixtures for use by the physically handicapped shall be in accordance with **ICC A117.1**.

3.3.4 Fixture Supports

Fixture supports for off-the-floor lavatories, urinals, water closets, and other fixtures of similar size, design, and use, shall be of the chair-carrier type. The carrier shall provide the necessary means of mounting the fixture, with a foot or feet to anchor the assembly to the floor slab. Adjustability shall be provided to locate the fixture at the desired height and in proper relation to the wall. Support plates, in lieu of chair carrier, shall be fastened to the wall structure only where it is not possible to anchor a floor-mounted chair carrier to the floor slab.

3.3.4.1 Support for Solid Masonry Construction

Chair carrier shall be anchored to the floor slab. Where a floor-anchored chair carrier cannot be used, a suitable wall plate shall be imbedded in the masonry wall.

3.3.4.2 Support for Concrete-Masonry Wall Construction

Chair carrier shall be anchored to floor slab. Where a floor-anchored chair carrier cannot be used, a suitable wall plate shall be fastened to the concrete wall using through bolts and a back-up plate.

3.3.4.3 Support for Steel Stud Frame Partitions

Chair carrier shall be used. The anchor feet and tubular uprights shall be of the heavy duty design; and feet (bases) shall be steel and welded to a square or rectangular steel tube upright. Wall plates, in lieu of floor-anchored chair carriers, shall be used only if adjoining steel partition studs are suitably reinforced to support a wall plate bolted to these studs.

3.3.4.4 Wall-Mounted Water Closet Gaskets

Where wall-mounted water closets are provided, reinforced wax, treated felt, or neoprene gaskets shall be provided. The type of gasket furnished shall be as recommended by the chair-carrier manufacturer.

3.3.5 Backflow Prevention Devices

Plumbing fixtures, equipment, and pipe connections shall not cross connect or interconnect between a potable water supply and any source of nonpotable water. Backflow preventers shall be installed where indicated and in accordance with **IAPMO UPC** at all other locations necessary to preclude a cross-connect or interconnect between a potable water supply and any nonpotable substance. In addition backflow preventers shall be installed at all locations where the potable water outlet is below the flood level of the equipment, or where the potable water outlet will be located below the level of the nonpotable substance. Backflow preventers shall be located so that no part of the device will be submerged. Backflow preventers shall be of sufficient size to allow unrestricted flow of water to the equipment, and preclude the backflow of any nonpotable substance into the potable water system. Bypass piping shall not be provided around backflow preventers. Access shall be provided for maintenance and testing. Each device shall be a standard commercial unit.

3.3.6 Access Panels

Access panels shall be provided for concealed valves and controls, or any item requiring inspection or maintenance. Access panels shall be of sufficient size and located so that the concealed items may be serviced, maintained, or replaced. Access panels shall be as specified in Section 08 31 00 ACCESS DOORS AND PANELS.

3.3.7 Sight Drains

Sight drains shall be installed so that the indirect waste will terminate 2 inches above the flood rim of the funnel to provide an acceptable air gap.

3.3.8 Traps

Each trap shall be placed as near the fixture as possible, and no fixture shall be double-trapped. Traps installed on cast-iron soil pipe shall be cast iron. Traps installed on steel pipe or copper tubing shall be recess-drainage pattern, or brass-tube type. Traps installed on plastic pipe may be plastic conforming to ASTM D3311. Traps for acid-resisting waste shall be of the same material as the pipe.

3.4 VIBRATION-ABSORBING FEATURES

Mechanical equipment, including compressors and pumps, shall be isolated from the building structure by approved vibration-absorbing features, unless otherwise shown. Each foundation shall include an adequate number of standard isolation units. Each unit shall consist of machine and floor or foundation fastening, together with intermediate isolation material, and shall be a standard product with printed load rating. Piping connected to mechanical equipment shall be provided with flexible connectors. Isolation unit installation shall limit vibration to 20-40 percent of the lowest equipment rpm.

3.5 WATER METER REMOTE READOUT REGISTER

The remote readout register shall be mounted at the location indicated or as directed by the Contracting Officer.

3.6 IDENTIFICATION SYSTEMS

3.6.1 Identification Tags

Identification tags made of brass, engraved laminated plastic, or engraved anodized aluminum, indicating service and valve number shall be installed on valves, except those valves installed on supplies at plumbing fixtures. Tags shall be 2 inch minimum diameter, and marking shall be stamped or engraved. Indentations shall be black, for reading clarity. Tags shall be attached to valves with No. 12 AWG, copper wire, chrome-plated beaded chain, or plastic straps designed for that purpose.

3.6.2 Pipe Color Code Marking

Color code marking of piping shall be as indicated below:

a. Pipe Label Color Schedule:

(1) Domestic Water Piping

- a) Background: Safety green.
- b. Letter Colors: White.

(1) Natural Gas Piping

- a) Background: Yellow.
- b) Letter Colors: Black.

3.6.3 Color Coding Scheme for Locating Hidden Utility Components

Scheme shall be provided in buildings having suspended grid ceilings. The color coding scheme shall identify points of access for maintenance and operation of operable components which are not visible from the finished space and installed in the space directly above the suspended grid ceiling. The operable components shall include valves, dampers, switches, linkages and thermostats. The color coding scheme shall consist of a color code board and colored metal disks. Each colored metal disk shall be approximately $\frac{3}{8}$ inch in diameter and secured to removable ceiling panels with fasteners. The fasteners shall be inserted into the ceiling panels so that the fasteners will be concealed from view. The fasteners shall be manually removable without tools and shall not separate from the ceiling panels when panels are dropped from ceiling height. Installation of colored metal disks shall follow completion of the finished surface on which the disks are to be fastened. The color code board shall have the approximate dimensions of 3 foot width, 30 inches height, and $\frac{1}{2}$ inch thickness. The board shall be made of wood fiberboard and framed under glass or $\frac{1}{16}$ inch transparent plastic cover. Unless otherwise directed, the color code symbols shall be approximately $\frac{3}{4}$ inch in diameter and the related lettering in $\frac{1}{2}$ inch high capital letters. The color code board shall be mounted and located in the mechanical or equipment room.

3.7 ESCUTCHEONS

Escutcheons shall be provided at finished surfaces where bare or insulated piping, exposed to view, passes through floors, walls, or ceilings, except in boiler, utility, or equipment rooms. Escutcheons shall be fastened securely to pipe or pipe covering and shall be satin-finish, corrosion-resisting steel, polished chromium-plated zinc alloy, or polished chromium-plated copper alloy. Escutcheons shall be either one-piece or split-pattern, held in place by internal spring tension or setscrew.

3.7.1 Escutcheons for New Piping:

Unless indicated otherwise, provide escutcheons as indicated below:

- a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
- b. Chrome-Plated Piping: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
- c. Insulated Piping: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed or exposed-rivet hinge.
- d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass or split-casting brass type with polished,

chrome-plated finish.

- e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
- f. Bare Piping in Unfinished Service Spaces: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed or exposed-rivet hinge.
- g. Bare Piping in Equipment Rooms: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed or exposed-rivet hinge.

3.7.2 Escutcheons for Existing Piping:

- a. Chrome-Plated Piping: Split-casting brass type with polished, chrome-plated finish.
- b. Insulated Piping: Split-plate, stamped-steel type with concealed or exposed-rivet hinge.
- c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-casting brass type with polished, chrome-plated finish.
- d. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-casting brass type with polished, chrome-plated finish.
- e. Bare Piping in Unfinished Service Spaces: Split-plate, stamped-steel type with concealed or exposed-rivet hinge.
- f. Bare Piping in Equipment Rooms: Split-plate, stamped-steel type with concealed or exposed-rivet hinge.

3.7.3 Floor Plates

Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

- a. New Piping: One-piece, floor-plate type.
- b. Existing Piping: Split-casting, floor-plate type.

3.8 PAINTING

Painting of pipes, hangers, supports, and other iron work, either in concealed spaces or exposed spaces, is specified in Section 09 90 00 PAINTS AND COATINGS.

3.8.1 Painting of New Equipment

New equipment painting shall be factory applied or shop applied, and shall be as specified herein, and provided under each individual section.

3.8.1.1 Factory Painting Systems

Manufacturer's standard factory painting systems may be provided subject to certification that the factory painting system applied will withstand 125 hours in a salt-spray fog test, except that equipment located outdoors shall withstand 500 hours in a salt-spray fog test. Salt-spray fog test

shall be in accordance with **ASTM B117**, and for that test the acceptance criteria shall be as follows: immediately after completion of the test, the paint shall show no signs of blistering, wrinkling, or cracking, and no loss of adhesion; and the specimen shall show no signs of rust creepage beyond **0.125 inch** on either side of the scratch mark.

The film thickness of the factory painting system applied on the equipment shall not be less than the film thickness used on the test specimen. If manufacturer's standard factory painting system is being proposed for use on surfaces subject to temperatures above **120 degrees F**, the factory painting system shall be designed for the temperature service.

3.8.1.2 Shop Painting Systems for Metal Surfaces

Clean, pretreat, prime and paint metal surfaces; except aluminum surfaces need not be painted. Apply coatings to clean dry surfaces. Clean the surfaces to remove dust, dirt, rust, oil and grease by wire brushing and solvent degreasing prior to application of paint, except metal surfaces subject to temperatures in excess of **120 degrees F** shall be cleaned to bare metal.

Where more than one coat of paint is specified, apply the second coat after the preceding coat is thoroughly dry. Lightly sand damaged painting and retouch before applying the succeeding coat. Color of finish coat shall be aluminum or light gray.

- a. Temperatures Less Than **120 Degrees F**: Immediately after cleaning, the metal surfaces subject to temperatures less than **120 degrees F** shall receive one coat of pretreatment primer applied to a minimum dry film thickness of **0.3 mil**, one coat of primer applied to a minimum dry film thickness of **one mil**; and two coats of enamel applied to a minimum dry film thickness of **one mil** per coat.
- b. Temperatures Between **120 and 400 Degrees F**: Metal surfaces subject to temperatures between **120 and 400 degrees F** shall receive two coats of **400 degrees F** heat-resisting enamel applied to a total minimum thickness of **2 mils**.
- c. Temperatures Greater Than **400 Degrees F**: Metal surfaces subject to temperatures greater than **400 degrees F** shall receive two coats of **600 degrees F** heat-resisting paint applied to a total minimum dry film thickness of **2 mils**.

3.9 TESTS, FLUSHING AND DISINFECTION

3.9.1 Plumbing System

The following tests shall be performed on the plumbing system in accordance with **IAPMO UPC**, except that the drainage and vent system final test shall include the smoke test. The Contractor has the option to perform a peppermint test in lieu of the smoke test. If a peppermint test is chosen, the Contractor must submit a testing procedure and reasons for choosing this option in lieu of the smoke test to the Contracting Officer for approval.

- a. Drainage and Vent Systems Test. The final test shall include a smoke test.
- b. Building Sewers Tests.

c. Water Supply Systems Tests.

3.9.1.1 Test of Backflow Prevention Assemblies

Backflow prevention assembly shall be tested using gauges specifically designed for the testing of backflow prevention assemblies.

Backflow prevention assembly test gauges shall be tested annually for accuracy in accordance with the requirements of State or local regulatory agencies. If there is no State or local regulatory agency requirements, gauges shall be tested annually for accuracy in accordance with the requirements of University of Southern California's Foundation of Cross Connection Control and Hydraulic Research or the American Water Works Association Manual of Cross Connection (Manual M-14), or any other approved testing laboratory having equivalent capabilities for both laboratory and field evaluation of backflow prevention assembly test gauges. Report form for each assembly shall include, as a minimum, the following:

Data on Device	Data on Testing Firm
Type of Assembly	Name
Manufacturer	Address
Model Number	Certified Tester
Serial Number	Certified Tester No.
Size	Date of Test
Location	
Test Pressure Readings	Serial Number and Test Data of Gauges

If the unit fails to meet specified requirements, the unit shall be repaired and retested.

3.9.2 Defective Work

If inspection or test shows defects, such defective work or material shall be replaced or repaired as necessary and inspection and tests shall be repeated. Repairs to piping shall be made with new materials. Caulking of screwed joints or holes will not be acceptable.

3.9.3 System Flushing

3.9.3.1 During Flushing

Before operational tests or disinfection, potable water piping system shall be flushed with potable water. Sufficient water shall be used to produce a water velocity that is capable of entraining and removing debris in all portions of the piping system. This requires simultaneous operation of all fixtures on a common branch or main in order to produce a flushing velocity of approximately 4 fps through all portions of the piping system. In the event that this is impossible due to size of

system, the Contracting Officer (or the designated representative) shall specify the number of fixtures to be operated during flushing. Contractor shall provide adequate personnel to monitor the flushing operation and to ensure that drain lines are unobstructed in order to prevent flooding of the facility. Contractor shall be responsible for any flood damage resulting from flushing of the system. Flushing shall be continued until entrained dirt and other foreign materials have been removed and until discharge water shows no discoloration. All faucets and drinking water fountains, to include any device considered as an end point device by NSF/ANSI 61, Section 9, shall be flushed a minimum of 0.25 gallons per 24 hour period, ten times over a 14 day period.

3.9.3.2 After Flushing

System shall be drained at low points. Strainer screens shall be removed, cleaned, and replaced. After flushing and cleaning, systems shall be prepared for testing by immediately filling water piping with clean, fresh potable water. Any stoppage, discoloration, or other damage to the finish, furnishings, or parts of the building due to the Contractor's failure to properly clean the piping system shall be repaired by the Contractor. When the system flushing is complete, the hot-water system shall be adjusted for uniform circulation. Flushing devices and automatic control systems shall be adjusted for proper operation according to manufacturer's instructions. Flow rates on fixtures must not exceed those stated in PART 2 of this Section. Unless more stringent local requirements exist, lead levels shall not exceed limits established by 40 CFR 141.80 (c)(1). The water supply to the building shall be tested separately to ensure that any lead contamination found during potable water system testing is due to work being performed inside the building.

3.9.4 Operational Test

Upon completion of flushing and prior to disinfection procedures, the Contractor shall subject the plumbing system to operating tests to demonstrate satisfactory installation, connections, adjustments, and functional and operational efficiency. Such operating tests shall cover a period of not less than 8 hours for each system and shall include the following information in a report with conclusion as to the adequacy of the system:

- a. Time, date, and duration of test.
- b. Water pressures at the most remote and the highest fixtures.
- c. Operation of each fixture and fixture trim.
- d. Operation of each valve, hydrant, and faucet.
- e. Pump suction and discharge pressures.
- f. Temperature of each domestic hot-water supply.
- g. Operation of each floor and roof drain by flooding with water.
- h. Operation of each vacuum breaker and backflow preventer.

3.9.5 Disinfection

After all system components are provided and operational tests are

complete, the entire domestic hot- and cold-water distribution system shall be disinfected. Before introducing disinfecting chlorination material, entire system shall be flushed with potable water until any entrained dirt and other foreign materials have been removed.

Water chlorination procedure shall be in accordance with AWWA C651 and AWWA C652 as modified and supplemented by this specification. The chlorinating material shall be hypochlorites or liquid chlorine. The chlorinating material shall be fed into the water piping system at a constant rate at a concentration of at least 50 parts per million (ppm). Feed a properly adjusted hypochlorite solution injected into the system with a hypochlorinator, or inject liquid chlorine into the system through a solution-feed chlorinator and booster pump until the entire system is completely filled.

Test the chlorine residual level in the water at 6 hour intervals for a continuous period of 24 hours. If at the end of a 6 hour interval, the chlorine residual has dropped to less than 25 ppm, flush the piping including tanks with potable water, and repeat the above chlorination procedures. During the chlorination period, each valve and faucet shall be opened and closed several times.

After the second 24 hour period, verify that no less than 25 ppm chlorine residual remains in the treated system. The 24 hour chlorination procedure must be repeated until no less than 25 ppm chlorine residual remains in the treated system.

Upon the specified verification, the system including tanks shall then be flushed with potable water until the residual chlorine level is reduced to less than one part per million. During the flushing period, each valve and faucet shall be opened and closed several times.

Take additional samples of water in disinfected containers, for bacterial examination, at locations specified by the Contracting Officer. Test these samples for total coliform organisms (coliform bacteria, fecal coliform, streptococcal, and other bacteria) in accordance with AWWA 10084. The testing method used shall be EPA approved for drinking water systems and shall comply with applicable local and state requirements.

Disinfection shall be repeated until bacterial tests indicate the absence of coliform organisms (zero mean coliform density per 100 milliliters) in the samples for at least 2 full days. The system will not be accepted until satisfactory bacteriological results have been obtained.

3.10 POSTED INSTRUCTIONS

Framed instructions under glass or in laminated plastic, including wiring and control diagrams showing the complete layout of the entire system, shall be posted where directed. Condensed operating instructions explaining preventive maintenance procedures, methods of checking the system for normal safe operation, and procedures for safely starting and stopping the system shall be prepared in typed form, framed as specified above for the wiring and control diagrams and posted beside the diagrams. The framed instructions shall be posted before acceptance testing of the systems.

3.11 PERFORMANCE OF WATER HEATING EQUIPMENT

Standard rating condition terms are as follows:

EF = Energy factor, minimum overall efficiency.

ET = Minimum thermal efficiency with 70 degrees F delta T.

SL = Standby loss is maximum (Btu/h) based on a 70 degrees F temperature difference between stored water and ambient requirements.

V = Rated volume in gallons

Q = Nameplate input rate in kW (Btu/h)

3.11.1 Storage Water Heaters

3.11.1.1 Gas

- a. Storage capacity of 50 gallons or less shall have a minimum energy factor (EF) of 0.67 or higher per FEMP requirements.
- b. Storage capacity of 20 gallons - or more and input rating of 75,000 Btu/h or less: minimum EF shall be 0.62 - 0.0019V per 10 CFR 430.
- c. Rating of less than 22980 W: (75,000 Btu/h) ET shall be 80 percent; maximum SL shall be $(Q/800+110 \times (V^{1/2}))$, per ANSI Z21.10.3/CSA 4.3

3.11.2 Unfired Hot Water Storage

All volumes and inputs: shall meet or exceed R-12.5.

3.12 PLUMBING SYSTEM RECORD DOCUMENTS

Provide "Record" blue line prints at the completion of job. One complete set of blue line prints will be furnished to the Contractor for record drawings. Keep a set of prints on the job and record day to day changes to Contract drawings with red pencil. Indicate actual location of piping, ductwork, valves, dampers, and equipment. Turn over prints to Architect at final observation.

After receipt of "Record" prints, Engineer will review and return to Contractor. Make all changes to "As-Built" drawings as stated above and on electronic media compatible with current AutoCad, (.DXF) files only. Provide auto-positive reproductions of all floor plans and riser diagram. Reduce 1/4 inch scale drawings to 1/2 size; 1/8 inch scale drawings to be full size; reduce Riser Diagram to 1/2 size.

3.13 TABLES

TABLE I								
PIPE AND FITTING MATERIALS FOR DRAINAGE, WASTE, VENT AND CONDENSATE DRAIN PIPING SYSTEMS								
Item #	Pipe and Fitting Materials	SERVICE A	SERVICE B	SERVICE C	SERVICE D	SERVICE E	SERVICE F	SERVICE G
1	Cast iron soil pipe and fittings, hub and spigot, ASTM A74 with compression gaskets. Pipe and fittings shall be marked with the CISPI trademark.	X	X	X	X	X		
2	Cast iron soil pipe and fittings hubless, CISPI 301 and ASTM A888 . Pipe and fittings shall be marked with the CISPI trademark.		X	X	X	X		
3	Cast iron drainage fittings, threaded, ASME B16.12 for use with Item 10	X		X	X			
4	Cast iron screwed fittings (threaded) ASME B16.4 for use with Item 10				X	X		
5	Grooved pipe couplings, ferrous and non-ferrous pipe ASTM A536 And ASTM A47/A47M	X	X		X	X		
6	Ductile iron grooved joint fittings for ferrous pipe ASTM A536 and ASTM A47/A47M for use with Item 5	X	X		X	X		

TABLE I								
PIPE AND FITTING MATERIALS FOR DRAINAGE, WASTE, VENT AND CONDENSATE DRAIN PIPING SYSTEMS								
Item #	Pipe and Fitting Materials	SERVICE A	SERVICE B	SERVICE C	SERVICE D	SERVICE E	SERVICE F	SERVICE G
7	Bronze sand casting grooved joint pressure fittings for non-ferrous pipe ASTM B584, for use with Item 5	X	X		X	X		
8	Wrought copper grooved joint pressure fittings for non-ferrous pipe ASTM B75/B75M C12200, ASTM B152/B152M, C11000, ASME B16.22 ASME B16.22 for use with Item 5	X	X					
9	Malleable-iron threaded fittings, galvanized ASME B16.3 for use with Item 10				X	X		
10	Steel pipe, seamless galvanized, ASTM A53/A53M, Type S, Grade B	X			X	X		
11	Seamless red brass pipe, ASTM B43				X	X		X
12	Bronzed flanged fittings, ASME B16.24 for use with Items 11 and 14				X	X		X
13	Cast copper alloy solder joint pressure fittings, ASME B16.18 for use with Item 14				X	X		X
14	Seamless copper pipe, ASTM B42						X	X

TABLE I								
PIPE AND FITTING MATERIALS FOR DRAINAGE, WASTE, VENT AND CONDENSATE DRAIN PIPING SYSTEMS								
Item #	Pipe and Fitting Materials	SERVICE A	SERVICE B	SERVICE C	SERVICE D	SERVICE E	SERVICE F	SERVICE G
15	Cast bronze threaded fittings, ASME B16.15				X	X		
16	Copper drainage tube, (DWV), ASTM B306	X*	X	X*	X	X		X
17	Wrought copper and wrought alloy solder-joint drainage fittings. ASME B16.29	X	X	X	X	X		X
18	Cast copper alloy solder joint drainage fittings, DWV, ASME B16.23	X	X	X	X	X		X
19	Acrylonitrile-Butadiene (ABS) plastic drain, waste, and vent pipe and fittings ASTM D2661, ASTM F628	X	X	X	X	X	X	
20	Polyvinyl Chloride plastic drain, waste and vent pipe and fittings, ASTM D2665, ASTM F891, (Sch 40) ASTM F1760	X	X	X	X	X	X	X
21	Process glass pipe and fittings, ASTM C1053						X	
22	High-silicon content cast iron pipe and fittings (hub and spigot, and mechanical joint), ASTM A518/A518M		X			X	X	

TABLE I								
PIPE AND FITTING MATERIALS FOR DRAINAGE, WASTE, VENT AND CONDENSATE DRAIN PIPING SYSTEMS								
It #	Pipe and Fitting Materials	SERVICE A	SERVICE B	SERVICE C	SERVICE D	SERVICE E	SERVICE F	SERVICE G
23	Polypropylene (PP) waste pipe and fittings, ASTM D4101						X	
24	Filament-wound reinforced thermosetting resin (RTRP) pipe, ASTM D2996						X	
SERVICE: A - Underground Building Soil, Waste and Storm Drain B - Aboveground Soil, Waste, Drain In Buildings C - Underground Vent D - Aboveground Vent E - Interior Rainwater Conductors Aboveground F - Corrosive Waste And Vent Above And Belowground G - Condensate Drain Aboveground * - Hard Temper								

TABLE III				
STANDARD RATING CONDITIONS AND MINIMUM PERFORMANCE RATINGS FOR WATER HEATING EQUIPMENT				
FUEL	STORAGE CAPACITY GALLONS	INPUT RATING	TEST PROCEDURE	REQUIRED PERFORMANCE
A. STORAGE WATER HEATERS				
Gas	1,000 (Btu/h)/gal max.	75,000 Btu/h	ANSI Z21.10.3/C8	ET = 80 percent min. SL = 1.3+38/V max.
TERMS: EF = Energy factor, minimum overall efficiency. ET = Minimum thermal efficiency with 70 degrees F delta T. SL = Standby loss is maximum Btu/h based on a 70 degree F temperature difference between stored water and ambient requirements. V = Rated storage volume in gallons Q = Nameplate input rate in Btu/h				

-- End of Section --

SECTION 22 05 48.00 20

MECHANICAL SOUND, VIBRATION, AND SEISMIC CONTROL

04/06, CHG 1: 05/15

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M (2020; Errata 1 2021) Structural Welding
Code - Steel

ASTM INTERNATIONAL (ASTM)

ASTM A123/A123M (2017) Standard Specification for Zinc
(Hot-Dip Galvanized) Coatings on Iron and
Steel Products

ASTM E84 (2020) Standard Test Method for Surface
Burning Characteristics of Building
Materials

1.2 RELATED REQUIREMENTS

The provisions of Section 23 03 00.00 20 BASIC MECHANICAL MATERIALS AND METHODS apply to this section.

1.3 DEFINITIONS

1.3.1 Decibels dB

Measure of sound level. Decibels are referenced to either 20 uPa for sound pressure levels or one pW for sound power levels. dBA is the overall "A" weighted sound level.

1.3.2 Machinery

The vibration or noise producing equipment that must be isolated.

1.3.3 Manufacturer

The fabricator or supplier of vibration-isolation or seismic-protection materials and equipment. For mechanical equipment and machinery the term machinery manufacturer will be used.

1.3.4 Micropascal uPa

10 to the minus 6 power newtons per square meter.

1.3.5 Picowatt pW

10 to the minus 12 power watts.

1.4 SYSTEM DESCRIPTION

1.4.1 Spring Isolator Data

For each type and size of spring isolator, submit the spring outside diameter, deflection, operating spring height, unloaded spring height, solid spring height, the ratio of the outside diameter to the operating spring height, the load to deflection ratio of the springs, and weight and sizes of structural steel members.

1.4.2 Machinery Manufacturer's Sound Data

For each piece of indicated machinery to be vibration isolated, the calculated sound power test data or sound pressure test data as levels in dB in the eight octave bands between 63 and 8,000 Hz. Refer sound power levels to one pW and sound pressure levels to 20 uPa. Submit the overall "A" weighted scale sound pressure level in dB. Submit the standard test procedure used to obtain the sound power or pressure data for the applicable vibration isolation equipment size.

1.4.3 Machinery

For each item of machinery, compare spring static deflections with the specified minimum static deflection, to show that the calculated spring static deflections are not less than the minimum static deflections specified. Rated spring static deflections are not acceptable in lieu of calculated spring static deflections.

1.4.4 Machinery Vibration Criteria

TABLE 1A						
Vibration Isolator Types and Minimum Static Deflection						
(MSD, inches) for 4-8 inch slab on grade and column supported.						
Column Spacing	Slab on earth and 0-30 feet		31-40 feet		41-50 feet	
Equipment	Type (Note (1))	MSD (Note (1))	Type (Note (1))	MSD (Note (1))	Type (Note (1))	MSD (Note (1))
Absorption Refrigeration Machines	SV-R	1.0	SV-R	1.75	SV-R	2.75
Centrifugal Chillers or Heat Pumps						
Hermetic Type	SV-B	1.75	SV-B	2.5	SV-B	3.5

TABLE 1A						
Vibration Isolator Types and Minimum Static Deflection						
(MSD, inches) for 4-8 inch slab on grade and column supported.						
Column Spacing	Slab on earth and 0-30 feet		31-40 feet		41-50 feet	
Equipment	Type (Note (1))	MSD (Note (1))	Type (Note (1))	MSD (Note (1))	Type (Note (1))	MSD (Note (1))
Open Type	SV-1	1.75	SV-I	2.5	SV-I	3.5
Reciprocating Air or Refrigeration Compressors						
500 to 750 rpm	S-R	1.75	S-R	2.5	S-R	3.5
751 rpm and up	S-R	1.5	S-R	2.5	S-R	3.5
Reciprocating Chillers or Heat Pumps						
500 to 750 rpm	SV-R	1.75	SV-R	2.5	SV-R	3.5
751 rpm and up	SV-R	1.5	SV-R	2.5	SV-R	3.5
Packaged Boilers	SV	1.0	SV	2.5	SV-R	3.5
Closed Coupled Pumps						
Up to 7-1/2 hp	S-I	1.0	S-I	1.0	S-I	1.0
Over 7-1/2 hp	S-I	1.5	S-I	2.5	S-I	2.5
Base Mounted Pumps						
Up to 20 hp	S-I	1.5	S-I	2.5	S-I	2.5
20 to 75 hp	S-I	1.5	S-I	2.5	S-I	3.5
Over 75 hp	S-I	2.5	S-I	3.5	S-I	3.5

TABLE 1A						
Vibration Isolator Types and Minimum Static Deflection						
(MSD, inches) for 4-8 inch slab on grade and column supported.						
Column Spacing	Slab on earth and 0-30 feet		31-40 feet		41-50 feet	
<u>Equipment</u>	<u>Type (Note (1))</u>	<u>MSD (Note (1))</u>	<u>Type (Note (1))</u>	<u>MSD (Note (1))</u>	<u>Type (Note (1))</u>	<u>MSD (Note (1))</u>
Cooling Towers and Evaporative Condensers						
		SV with deflections specified for centrifugal blowers when springs are supported on beams. Use selection listed for column supported floors with up to 30 foot column spacing when springs are located on columns or bearing walls.				
Factory Assembled Air Handling Equipment AH, AC and HV Units (Note (2))						
Suspended Units						
Up to 5 hp	H	1.0	H	1.0	H	1.0
Over 5 hp						
Up to 400 rpm	H	1.75	H	1.75	H	1.75
Over 401 rpm	H	1.0	H	1.5	H	2.5
Floor Mounted Units						
Up to 5 hp	S	1.0	S	1.0	S	1.0
Over 5 hp						
Up to 400 rpm	S-R	1.75	S-R	1.75	S-R	2.5
Over 401 rpm	S-R	1.0	S-R	1.5	S-R	2.5
Centrifugal Blowers						
175 - 224 rpm	S-B	4.75	S-B	4.75	S-B	4.75
225 - 299 rpm	S-B	3.75	S-B	4.75	S-B	4.75

TABLE 1A						
Vibration Isolator Types and Minimum Static Deflection						
(MSD, inches) for 4-8 inch slab on grade and column supported.						
Column Spacing	Slab on earth and 0-30 feet		31-40 feet		41-50 feet	
Equipment	Type (Note (1))	MSD (Note (1))	Type (Note (1))	MSD (Note (1))	Type (Note (1))	MSD (Note (1))
300 - 374 rpm	S-B	2.75	S-B	4.5	S-B	4.75
375 - 499 rpm	S-B	2.5	S-B	3.5	S-B	4.5
Over 500 rpm	S-B	1.75	S-B	2.5	S-B	3.5
Tubular Centrifugal and Axial Fans (Note (2))						
Suspended		H with deflection specified for centrifugal blowers				
Floor Mounted Arrangements 1 & 9		S-B with deflections specified for centrifugal blowers				
Utility Fans (Note (2))						
Suspended		H with deflections specified for centrifugal blowers but not to exceed 2.75 inches				
Floor-Mounted		S-R with deflections not specified for centrifugal blowers but not to exceed 2.75 inches				
High Pressure Fans (6 Inch Water-Column Static Pressure) and Other Machineries Producing Thrust (Note (2))		HR recommended for minimizing undesirable thrust effects				
Internal Combustion Engines and Engine Driven Equip						
750 rpm and over	S	1.5	S	2.5	S	3.5
Dimmer Banks and Transformers						
Up to 1000 lbs.	NM	0.35	NM	0.35	NM	3.5
Over 1000 lbs.	SV	1.0	SV	1.0	SV	1.0

TABLE 1A						
Vibration Isolator Types and Minimum Static Deflection						
(MSD, inches) for 4-8 inch slab on grade and column supported.						
Column Spacing	Slab on earth and 0-30 feet		31-40 feet		41-50 feet	
Equipment	Type (Note (1))	MSD (Note (1))	Type (Note (1))	MSD (Note (1))	Type (Note (1))	MSD (Note (1))
NOTES:						
(1) Equipment Vibration Isolation Schedule Designations (Hyphenated designations are combinations of the following:)						
B - Welded structural steel bases.						
H - Spring isolators (suspended equipment and piping). Where required, provide with adjustable preloading devices.						
HR - Thrust restraints						
I - Concrete inertia bases with steel forms.						
NM - Neoprene mounts.						
NP - Neoprene pads.						
R - Structural steel rail for equipment mounts.						
S - Freestanding spring isolators (floor-mounted equipment).						
SV - Freestanding spring isolators (floor-mounted equipment).						
SX - Freestanding spring isolators with adjustable cushioned vertical stops and cushioned horizontal stops (floor-mounted equipment). Protected spring isolators SX may be substituted wherever S or SV is specified and shall meet all requirements.						
(2) Fans						
a. When fan motors are 75 hp or larger, use the deflection requirements for the next wider column spacing. Except for building slab on grade a minimum of 2.5 inches should be used unless larger deflections are specified in the centrifugal blower table.						
b. Provide sway brace isolators for tubular centrifugal and axial fans when the fan pressure exceeds 4 inches water column.						
c. Provide inertia bases for all fans in lieu of structural steel bases or rails specified above when the fan pressure exceeds 4 inches water column.						

TABLE 1A						
Vibration Isolator Types and Minimum Static Deflection						
(MSD, inches) for 4-8 inch slab on grade and column supported.						
Column Spacing	Slab on earth and 0-30 feet		31-40 feet		41-50 feet	
Equipment	Type (Note (1))	MSD (Note (1))	Type (Note (1))	MSD (Note (1))	Type (Note (1))	MSD (Note (1))
d. With attaching brackets, suspension spring isolators bridge between the structure and the thrust-producing machinery such as high-pressure fan. Both types H and HR normally provide reaction in tension, while types S, SV, and SX normally provide reaction in compression. Thrust restraints are low-cost and effective components available from manufacturers. Use thrust restraints to eliminate the need for or reduce the magnitude of inertia mass when the mass is only used to reduce the displacement effects of the thrust.						

TABLE 1B		
Class II Vibration Isolator Types and Minimum Static Deflection		
(MSD, inches) for basements below grade and floor slabs on earth		
Equipment	Type (Note (1))	MSD
Absorption Refrigeration Machines	NP	0.25
	NM	0.35
Centrifugal Chillers or Heat Pumps		
Hermetic Type	NP	0.25
	NM	0.35
Open Type	NM-I	0.35
Reciprocating Air or Refrigeration Compressors		
500 to 750 rpm	S	1.0
751 rpm and up	S	1.0
Reciprocating Chillers or Heat Pumps		
500 to 750 rpm	SV	1.0
751 rpm and up	SV	1.0
Packaged Boilers	NP	0.25
	NM	0.35
Pumps		

TABLE 1B		
Class II Vibration Isolator Types and Minimum Static Deflection		
(MSD, inches) for basements below grade and floor slabs on earth		
Equipment	Type (Note (1))	MSD
Closed Coupled	NP	0.25
Up to 7 1/2 hp	NM	0.35
Over 7 1/2 hp	S-I	1.0
Base Mounted		
Up to 20 hp	S-I	1.0
20 to 75 hp	S-I	1.0
Over 75 hp	S-I	1.0
Cooling Towers and Evaporative Condensers	NP	0.25
	NM	0.35
Factory Assembled Air Handling Equipment AH, AC and HV Units (Note (2))		
Suspended Units		
Up to 5 hp	H	1.0
Over 5 hp		
Up to 400 rpm	H	1.75
Over 401 rpm	H	1.0
Floor Mounted Units		
Up to 5 hp	NP	0.25
	NM	0.35
Over 5 hp		
Up to 400 rpm	NM	0.35
Over 401 rpm	NM	0.35
Centrifugal Blowers		
175 - 224 rpm	NM-B	0.35
225 - 299 rpm	NM-B	0.35
300 - 374 rpm	NM-B	0.35
375 - 499 rpm	NM-B	0.35
Over 500 rpm	NM-B	0.35
Tubular Centrifugal and Axial Fans (Note (2))		
Suspended	H with deflections specified for centrifugal blowers	
Floor Mounted Arrangements 1 & 9	NM	0.35

TABLE 1B		
Class II Vibration Isolator Types and Minimum Static Deflection		
(MSD, inches) for basements below grade and floor slabs on earth		
Equipment	Type (Note (1))	MSD
Utility Fans (Note (2))		
Suspended and centrifugal	H with deflections specified for	
Floor-Mounted	NM	0.35
High Pressure Fans (Over 6 Inch Water-Column Static Pressure) and Other Machineries Producing Thrust Note (2))		HR recommended for minimizing undesirable thrust effects
Internal Combustion Engines and Engine Driven Equip		
750 rpm and over	S	1.0
Dimmer Banks and Transformers		
Up to 1000 lbs.	NP	0.25
	NM	0.35
Over 1000 lbs.	SV	1.0
NOTES: Note (1) and Note (2) are same as for TABLE 1A.		

Provide vibration isolators for mechanical and electrical machinery and associated piping and ductwork as indicated, to minimize transmission of vibrations and structure borne noise to the building structure or spaces or from the building structure to the machinery. Comply with the following vibration schedule.

1.4.5 Machinery Airborne Sound Level Criteria

TABLE 2A								
Sound Data Schedule								
Equipment	Maximum Sound Power Level (dB)							
	Octave Band Level Center Frequency (Hz)							
	63	125	250	500	1000	2000	4000	8000
Air Handling Unit	94	90	89	89	89	84	82	79
Make-Up Air Fan	91	91	80	84	82	76	71	65

TABLE 2A								
Sound Data Schedule								
Equipment	Maximum Sound Power Level (dB)							
	Octave Band Level Center Frequency (Hz)							
	63	125	250	500	1000	2000	4000	8000
Air Conditioning Unit	100	96	90	89	86	80	75	72
Boiler	75	72	72	75	76	63	55	50
Chiller	98	98	96	95	93	94	88	81
Cooling Tower	110	110	105	102	98	95	92	87
Air Compressor	90	89	92	93	92	92	90	81
Pump	85	80	82	82	80	77	74	72
Fan	55	50	48	47	48	46	42	37

1.4.5.1 Basic Criteria

For each piece of machinery in the human work environment, do not exceed the maximum airborne sound levels 84 dB A-weighted scale, continuous or intermittent, or 140 dB peak sound pressure-level, impact or impulse, noise.

1.4.5.2 Sound Data Schedule

TABLE 2A								
Sound Data Schedule								
Equipment	Maximum Sound Power Level (dB)							
	Octave Band Level Center Frequency (Hz)							
	63	125	250	500	1000	2000	4000	8000
Air Handling Unit	94	90	89	89	89	84	82	79
Make-Up Air Fan	91	91	80	84	82	76	71	65
Air Conditioning Unit	100	96	90	89	86	80	75	72

TABLE 2A								
Sound Data Schedule								
Equipment	Maximum Sound Power Level (dB)							
	Octave Band Level Center Frequency (Hz)							
	63	125	250	500	1000	2000	4000	8000
Boiler	75	72	72	75	76	63	55	50
Chiller	98	98	96	95	93	94	88	81
Cooling Tower	110	110	105	102	98	95	92	87
Air Compressor	90	89	92	93	92	92	90	81
Pump	85	80	82	82	80	77	74	72
Fan	55	50	48	47	48	46	42	37

1.4.6 Welding

AWS D1.1/D1.1M.

1.5 SUBMITTALS

Government approval is required for submittals. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Pipe Guides

Vertical Stops

Machinery Manufacturer's Sound Data

Elastomeric Isolation Pads

Suspension Isolators

SD-05 Design Data

Machinery

SD-06 Test Reports

Equipment Vibration Tests

Protected Spring Isolators

Submit seismic protection rating in three principal axes certified by an independent laboratory or analyzed by an independent licensed structural engineer.

SD-08 Manufacturer's Instructions

Vibration and Noise Isolation Components

1.6 QUALITY ASSURANCE

1.6.1 Vibration Isolator Procurement

For each piece of machinery to be isolated from vibration, supply the inertia basevibration isolators, and other associated materials and equipment as a coordinated package by a single manufacturer or by the machinery manufacturer. Select isolators that provide uniform deflection even when machinery weight is not evenly distributed. This requirement does not include the flexible connectors or the hangers for the associated piping and ductwork.

1.6.2 Unitized Machinery Assemblies

Mounting of unitized assemblies directly on vibration isolation springs is acceptable if machinery manufacturer certifies that the end supports of the assemblies have been designed for such installation.

PART 2 PRODUCTS

2.1 CORROSION PROTECTION FOR STEEL PARTS

ASTM A123/A123M hot-dipped galvanized, or equivalent manufacturer standard coatings. Where steel parts are exposed to the weather, provide galvanized coating of at least 2 ounces of zinc per square foot of surface. Coat springs with neoprene.

2.2 ELASTOMERIC ISOLATION PADS

- a. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
- b. Size: Factory or field cut to match requirements of supported equipment.
- c. Pad Material: Oil and water resistant with elastomeric properties.
- d. Surface Pattern: Smooth, ribbed or waffle pattern.
- e. Infused nonwoven cotton or synthetic fibers.
- f. Load-bearing metal plates adhered to pads.
- g. Sandwich-Core Material: Resilient and elastomeric.
 - (1) Surface Pattern: Smooth, ribbed or waffle pattern.
 - (2) Infused nonwoven cotton or synthetic fibers.

2.3 ELASTOMERIC ISOLATION MOUNTS

- a. Double-Deflection, Elastomeric Isolation Mounts:
 - (1) Mounting Plates:

- a) Top Plate: Encapsulated steel load transfer top plates, factory drilled and threaded with threaded studs or bolts.
 - b) Baseplate: Encapsulated steel bottom plates with holes provided for anchoring to support structure.
- (2) Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

2.4 RESTRAINED ELASTOMERIC ISOLATION MOUNTS

- a. Description: All-directional isolator with restraints containing two separate and opposing elastomeric elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
 - (1) Housing: Cast-ductile iron or welded steel.
 - (2) Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

2.5 SPRING ISOLATORS AND PROTECTED SPRING ISOLATORS

Provide spring isolators or protected spring isolators that are adjustable and laterally stable with free-standing springs of horizontal stiffness at minimum 80 percent of the vertical (axial) stiffness. For machine-attached and floor-attached restraining elements, separate from metal-to-metal contact by neoprene cushions 1/8 inch thick minimum. Provide neoprene acoustic friction pads at least 1/4 inch thick.

2.5.1 OPEN-SPRING ISOLATORS

- a. Freestanding, Laterally Stable, Open-Spring Isolators:
 - (1). Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 - (2) Minimum Additional Travel: 50 percent of the required deflection at rated load.
 - (3) Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 - (4) Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 - (5) Baseplates: Factory-drilled steel plate for bolting to structure with an elastomeric isolator pad attached to the underside. Baseplates shall limit floor load to 500 psig.
 - (6) Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

2.5.2 HOUSED-SPRING ISOLATORS

- a. Freestanding, Laterally Stable, Open-Spring Isolators in Two-Part Telescoping Housing:
 - (1) Outside Spring Diameter: Not less than 80 percent of the

compressed height of the spring at rated load.

- (2) Minimum Additional Travel: 50 percent of the required deflection at rated load.
- (3) Lateral Stiffness: More than 80 percent of rated vertical stiffness.
- (4) Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
- (5) Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators.
 - a) Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig.
 - b) Top housing with threaded mounting holes and internal leveling device.

2.5.3 RESTRAINED-SPRING ISOLATORS

- a. Freestanding, Laterally Stable, Open-Spring Isolators with Vertical-Limit Stop Restraint:
 - (1) Housing: Steel housing with vertical-limit stops to prevent spring extension due to weight being removed.
 - a) Base with holes for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig.
 - b) Top plate with threaded mounting holes or elastomeric pad.
 - c) Internal leveling bolt that acts as blocking during installation.
 - (2) Restraint: Limit stop as required for equipment and authorities having jurisdiction.
 - (3) Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 - (4) Minimum Additional Travel: 50 percent of the required deflection at rated load.
 - (5) Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 - (6) Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.5.4 HOUSED-RESTRAINED-SPRING ISOLATORS

- a. Freestanding, Laterally Stable, Open-Spring Isolators with Vertical-Limit Stop Restraint:

- (1) Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators. Housings are equipped with adjustable snubbers to limit vertical movement.
 - a) Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig.
 - b) Threaded top housing with adjustment bolt and cap screw to fasten and level equipment.
- (2) Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
- (3) Minimum Additional Travel: 50 percent of the required deflection at rated load.
- (4) Lateral Stiffness: More than 80 percent of rated vertical stiffness.
- (5) Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.6 SUSPENSION ISOLATORS

Provide hangers with suspension isolators encased in open steel brackets. Isolate hanger rods from isolator steel brackets with neoprene-lined opening.

2.6.1 ELASTOMERIC HANGERS

- a. Elastomeric Mount in a Steel Frame with Upper and Lower Steel Hanger Rods:
 - (1) Frame: Steel, fabricated with a connection for an upper threaded hanger rod and an opening on the underside to allow for a maximum of 30 degrees of angular lower hanger-rod misalignment without binding or reducing isolation efficiency.
 - (2) Dampening Element: Molded, oil-resistant rubber, neoprene, or other elastomeric material with a projecting bushing for the underside opening preventing steel to steel contact.

2.6.2 SPRING HANGERS

- a. Combination Coil-Spring and Elastomeric-Insert Hanger with Spring and Insert in Compression:
 - (1) Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
 - (2) Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 - (3) Minimum Additional Travel: 50 percent of the required deflection at rated load.

- (4) Lateral Stiffness: More than 80 percent of rated vertical stiffness.
- (5) Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
- (6) Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
- (7) Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
- (8). Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

2.7 PIPE GUIDES

Factory-fabricated. Weld steel bar guides to the pipe at a maximum radial spacing of 60 degrees. The outside diameter around the guide bars shall be smaller than the inside diameter of the guide sleeve in accordance with standard field construction practice. For pipe temperatures below 60 degrees F, provide metal sleeve, minimum one pound per cubic foot density insulation.

2.7.1 PIPE-RISER RESILIENT SUPPORT

- a. Description: All-directional, acoustical pipe anchor consisting of two steel tubes separated by a minimum 1/2-inch- thick neoprene.
 - (1) Vertical-Limit Stops: Steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions.
 - (2) Maximum Load Per Support: 500 psig on isolation material providing equal isolation in all directions.

2.7.2 RESILIENT PIPE GUIDES

- a. Description: Telescopic arrangement of two steel tubes or post and sleeve arrangement separated by a minimum 1/2-inch- thick neoprene.
 - (1) Factory-Set Height Guide with Shear Pin: Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Vibration and Noise Isolation Components

Install vibration-and-noise isolation materials and equipment as indicated and in accordance with machinery manufacturer's instructions.

Installation of vibration isolators must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.

3.1.2 Suspension Vibration Isolators

Provide suspension isolation hangers for piping, suspended equipment, and

suspended equipment platforms in mechanical equipment rooms, as indicated and as specified. For operating load static deflections of $1/4$ inch or less, provide neoprene pads or single deflection neoprene isolators. For operating load static deflections over $5/16$ to $3/8$ inch, provide double-deflection neoprene element isolators. For operating load static deflections over $3/8$ inch, provide isolators with spring and neoprene elements in series.

3.1.3 Vertical Stops

For machinery affected by wind pressure or having an operational weight different from installed weight, provide resilient vertical limit stops which prevent spring extension when weight is removed. Provide vertical stops for machinery containing liquid, such as water chillers, evaporative coolers, boilers, and cooling towers. Spring isolated or protected spring isolated machinery must rock and move freely within limits of stops or seismic restraint devices.

3.1.4 Machinery

Provide vibration isolators, flexible connectors in accordance with manufacturer's recommendations. Machinery with spring isolators or protected spring isolators shall rock or move freely within limits of stops or seismic snubber restraints.

3.1.4.1 Stability

Isolators shall be stable during starting and stopping of machinery without traverse and eccentric movement of machinery that would damage or adversely affect the machinery or attachments.

3.1.4.2 Lateral Motion

The installed vibration isolation system for each piece of floor or ceiling mounted machinery shall have a maximum lateral motion under machinery start up and shut down conditions of not more than $1/4$ inch. Restrain motions in excess by approved spring mountings.

3.1.4.3 Unbalanced Machinery

Provide foundation suspension systems specifically designed to resist horizontal forces for machinery with large unbalanced horizontal forces. Vibration isolator systems shall conform to the machinery manufacturer's recommendations.

3.1.4.4 Nonrotating Machinery

Mount nonrotating machinery in systems which includes rotating or vibrating machinery on isolators having the same deflection as the hangers and supports for the pipe connected to.

3.1.5 Pipe Hanger and Support Installation

3.1.5.1 Pipe Hangers

Provide eye-bolts or swivel joints for pipe hangers to permit pipe thermal or mechanical movement without angular misalignment of hanger vibration isolator.

3.1.5.2 High Temperatures

Where neoprene elements of vibration isolator may be subjected to high pipe temperatures, above 160 degrees F, provide metal heat shields or thermal isolators.

3.1.5.3 Valves

Provide vibration isolation hangers and supports at modulating, pressure reducing, or control valves which will induce fluid pulsations. When required or indicated, isolate valves with flexible connectors.

3.1.5.4 Machinery Without Flexible Connections

When piping is not connected to vibrating machinery with flexible connectors, provide the first four hangers with isolation elements designed for deflections equal to equipment vibration isolator deflections (including static, operating, and start-up).

3.1.5.5 Twelve Inch and Larger Pipe

Suspend 12 inch and larger pipe vibration hangers from resilient hanger rod isolators. Resilient hanger rod isolators shall be capable of supporting pipe during installation at a fixed elevation regardless of load changes. Provide an adjustable preloading device to transfer the load to isolation element after operational load is applied. Provide 12 inch and larger pipe supports with unrestrained stable springs for one inch deflection and with built-in leveling device and resilient vertical limit stops to prevent spring elongation when partial load is removed. Provide isolators capable of providing rigid anchoring during erection of piping so that it can be erected at a fixed elevation.

3.1.5.6 Pipe Risers

Provide pipe riser supports with bearing plates and two layers of 1/4 inch thick ribbed or waffled neoprene pad loaded to not more than 50 psi. Separate isolation pads with 1/4 inch steel plate. Weld pipe riser clamps at anchor points to the pipe and to pairs of vertical acoustical pipe anchor mountings which shall be rigidly fastened to the steel framing.

3.1.5.7 Supports at Base of Pipe Risers

Piping isolation supports at the base of risers shall be two layers of 1/2 inch thick heavy-duty neoprene pad separated by 1/4 inch thick steel plate. Use bearing plates sized to provide a pad loading of not more than 500 psi. Weld the stanchion between the pipe and isolation support to the pipe and weld or bolt to the isolation support. Bolt isolation support to the floor slab with resilient sleeves and washers. Where supplementary steel is required to support piping, provide a maximum deflection of 0.08 inches at the mid-span of this steel under the load. Rigidly support piping from the supplementary steel with the supplementary steel isolated from the building structure with isolators.

3.1.5.8 Pipe Anchors

Attach each end of the pipe anchor to an omni-directional pipe isolator which in turn shall be rigidly fastened to the steel framing or structural concrete. Provide a telescoping pipe isolator of two sizes of steel tubing separated by a minimum 1/2 inch thick pad of heavy-duty neoprene or

heavy-duty neoprene and canvas. Provide vertical restraints by similar material to prevent vertical travel in either direction. The load on the isolation material shall not exceed 500 psi.

3.1.6 Equipment Room Sound Isolation

Do not allow direct contact between pipe or ducts and walls, floor slabs, roofs, ceilings or partitions of equipment rooms.

3.1.6.1 Pipe Penetrations

Provide galvanized Schedule 40 pipe sleeves and tightly pack annular space between sleeves and pipe with insulation having a flame spread rating not more than 25 and a smoke developed rating not more than 50 when tested in accordance with ASTM E84, maximum effective temperature 1000 degrees F, bulk density 6 pounds/cu. ft. minimum. Provide uninsulated pipe with a one inch thick mineral fiber sleeve the full length of the penetration and seal each end with an interior or exterior and weather resistant non-hardening compound. Provide sealant and mineral-fiber sleeve of a flame spread rating not more than 25 and a smoke developed rating not more than 50 when tested in accordance with ASTM E84.

3.1.6.2 Duct Penetrations

Pack openings around ducts with mineral fiber insulation the full length of the penetration having a flame spread rating not more than 25 and a smoke developed rating not more than 50 when tested in accordance with ASTM E84. At each end of duct opening provide sealing collars and seal with an interior or exterior and weather resistant non-hardening compound.

3.1.6.3 Ducts Passing Through Equipment Rooms

Provide with sound insulation equal to the sound attenuation value of the wall, floor, or ceiling penetrated.

3.1.7 Systems Not To Be Vibration Isolated

Do not provide vibration isolation for electrical raceways and conduits or for fire protection, storm, sanitary, and domestic water piping systems which do not include pumps or other vibrating, rotating, or pulsating equipment including control and pressure reducing valves.

3.2 FIELD QUALITY CONTROL

Provide equipment and apparatus required for performing inspections and tests. Notify Contracting Officer 14 days prior to machinery vibration testing. Rebalance, adjust, or replace machinery with noise or vibration levels in excess of those given in the machinery specifications, or machinery manufacturer's data.

3.2.1 Field Inspections

Prior to initial operation, inspect the vibration isolators for conformance to drawings, specifications, and manufacturer's data and instructions. Check for vibration and noise transmission through connections, piping, ductwork, foundations, and walls. Check connector alignment before and after filling of system and during operation. Correct misalignment without damage to connector and in accordance with manufacturer's recommendations.

3.2.2 Spring Isolator Inspection

After installation of spring isolators or protected spring isolators, and seismic restraint devices, the machinery shall rock freely on its spring isolators within limits of stops or seismic restraint devices. Eliminate or correct interferences.

3.2.3 Tests

Adjust, repair, or replace isolators as required to reduce vibration and noise transmissions to specified levels.

3.2.3.1 Equipment Vibration Tests

Perform vibration tests to determine conformance with vibration isolation schedule indicated.

-- End of Section --

SECTION 22 13 00

FACILITY SANITARY SEWERAGE
05/23

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.23 (2021) Cast Copper Alloy Solder Joint
Drainage Fittings - DWV

ASTM INTERNATIONAL (ASTM)

ASTM A74 (2021) Standard Specification for Cast
Iron Soil Pipe and Fittings

ASTM A888 (2021a) Standard Specification for Hubless
Cast Iron Soil Pipe and Fittings for
Sanitary and Storm Drain, Waste, and Vent
Piping Applications

ASTM C564 (2020a) Standard Specification for Rubber
Gaskets for Cast Iron Soil Pipe and
Fittings

CAST IRON SOIL PIPE INSTITUTE (CISPI)

CISPI 301 (2018) Hubless Cast Iron Soil Pipe and
Fittings for Sanitary and Storm Drain,
Waste, and Vent Piping Applications

CISPI 310 (2012) Coupling for Use in Connection with
Hubless Cast Iron Soil Pipe and Fittings
for Sanitary and Storm Drain, Waste, and
Vent Piping Applications

1.2 SUBMITTALS

Government approval is required for submittals. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Hubless, Cast-Iron Soil Pipe And Fittings

SD-03 Product Data

Floor Drains

Floor Sinks

SD-03 Product Data

Piping Materials

SD-10 Operation and Maintenance Data

Sanitary Waste Piping Specialties

1.3 PROJECT/SITE CONDITIONS

1.3.1 Existing Conditions

Interruption of Existing Sanitary Waste Service: Do not interrupt service to facilities occupied by Government or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Notify Contracting Officer no fewer than seven days in advance of proposed interruption of sanitary waste service.
2. Do not proceed with interruption of sanitary waste service without Contracting Officer's written permission.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 PIPING MATERIALS

- a. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- b. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.1.2 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

- a. Pipe and Fittings: ASTM A74, Service class(es).
- b. Gaskets: ASTM C564, rubber.
- c. Calking Materials: ASTM B29, pure lead and oakum or hemp fiber.

2.1.3 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

- a. Pipe and Fittings: ASTM A888 or CISPI 301.
- b. CISPI, Hubless-Piping Couplings: ASTM C1277 and CISPI 310.

Description: Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C564, rubber sleeve with integral, center pipe stop.

- c. Heavy-Duty, Hubless-Piping Couplings: ASTM C1277 and ASTM C1540.

Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C564, rubber sleeve with integral, center pipe stop.

2.1.4 COPPER TUBE AND FITTINGS

- a. Copper Type DWV Tube: ASTM B306, drainage tube, drawn temper.
- b. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.
- c. Hard Copper Tube: ASTM B88, Type L water tube, drawn temper.
- d. Copper Pressure Fittings:
 - (1) Copper Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
 - (2) Copper Unions: MSS SP-123, copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.
- e. Solder: ASTM B32, lead free with ASTM B813, water-flushable flux.

2.1.5 SPECIALTY PIPE FITTINGS

2.1.5.1 Transition Couplings:

- a. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
- b. Shielded, Nonpressure Transition Couplings:
 - (1) Standard: ASTM C1460.
 - (2) Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
 - (3) End Connections: Same size as and compatible with pipes to be joined.

2.1.5.2 Dielectric Fittings:

- a. Dielectric Unions: ASSE 1079
 - (1) Pressure Rating: 125 psig minimum at 180 deg F.
 - (2) End Connections: Solder-joint copper alloy and threaded ferrous.
- b. Dielectric Flanges: ASSE 1079.
 - (1) Factory-fabricated, bolted, companion-flange assembly.
 - (2) Pressure Rating: 125 psig minimum at 180 deg F.
 - (3) End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

2.1.6 ENCASEMENT FOR UNDERGROUND METAL PIPING

- a. Standard: ASTM A674 or AWWA C105/A 21.5.
- b. Material: Linear low-density polyethylene film of 0.008-inch or high-density, cross-laminated polyethylene film of 0.004-inch minimum thickness.
- c. Form: Tube.
- d. Color: Natural.

2.2 SANITARY WASTE PIPING SPECIALTIES

Sanitary waste piping specialties shall bear label, stamp, or other markings of specified testing agency. Comply with NSF 14 for plastic sanitary waste piping specialty components.

Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing, and marked for intended location and application.

2.2.1 CLEANOUTS

2.2.1.1 Cast-Iron Exposed Cleanouts, CO:

- a. Standard: ASME A112.36.2M.
- b. Size: Same as connected drainage piping
- c. Body Material: Hubless, cast-iron soil pipe test tee as required to match connected piping.
- d. Closure: Countersunk, brass plug.
- e. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

2.2.1.2 Cast-Iron Exposed Floor Cleanouts, FCO:

- a. Standard: ASME A112.36.2M for threaded, adjustable housing cleanout.
- b. Size: Same as connected branch.
- c. Type: Threaded, adjustable housing.
- d. Body or Ferrule: Cast iron.
- e. Clamping Device: Not required.
- f. Outlet Connection: Inside caulk.
- g. Closure: Brass plug with tapered threads.
- h. Adjustable Housing Material: Cast iron with threads.
- i. Frame and Cover Material and Finish: Nickel-bronze, copper alloy.
- j. Frame and Cover Shape: Round.

- k. Top Loading Classification: Medium Duty.
- l. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.

2.2.1.3 Cast-Iron Wall Cleanouts, WCO:

- a. Standard: ASME A112.36.2M. Include wall access.
- b. Size: Same as connected drainage piping.
- c. Body: Hubless, cast-iron soil pipe test tee as required to match connected piping.
- d. Closure Plug: Brass; Countersunk head; Drilled and threaded for cover attachment screw; Same size as or not more than one size smaller than cleanout size.
- e. Wall Access: Round, flat, chrome-plated brass or stainless-steel cover plate with screw.

2.2.2 ROOF FLASHING ASSEMBLIES

Manufactured assembly made of 4.0-lb/sq. ft., 0.0625-inch- thick, lead flashing collar and skirt extending at least 6 inches from pipe, with galvanized-steel boot reinforcement and counterflashing fitting.

- a. Open-Top Vent Cap: Without cap.
- b. Low-Silhouette Vent Cap: With vandal-proof vent cap.
- c. Extended Vent Cap: With field-installed, vandal-proof vent cap.

2.2.3 THROUGH-PENETRATION FIRESTOP ASSEMBLIES

- a. Standard: UL 1479 assembly of sleeve-and-stack fitting with firestopping plug.
- b. Size: Same as connected soil, waste, or vent stack.
- c. Sleeve: Molded-PVC plastic, of length to match slab thickness and with integral nailing flange on one end for installation in cast-in-place concrete slabs.
- d. Stack Fitting: ASTM A 48/A 48M, gray-iron, hubless-pattern wye branch with neoprene O-ring at base and gray-iron plug in thermal-release harness. Include PVC protective cap for plug.
- e. Special Coating: Corrosion resistant on interior of fittings.

2.2.4 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

2.2.4.1 Open Drains:

Shop or field fabricate from ASTM A 74, Service class, hub-and-spigot, cast-iron soil-pipe fittings. Include P-trap, hub-and-spigot riser section; and where required, increaser fitting joined with ASTM C 564 rubber gaskets.

1. Size: Same as connected waste piping with increaser fitting of size indicated.

2.2.4.2 Deep-Seal Traps:

Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap-seal primer valve connection.

- a. Size: Same as connected waste piping with increaser fitting of size indicated.

- (1) NPS 2: 4-inch-minimum water seal.

- (2) NPS 2-1/2 and Larger: 5-inch-minimum water seal.

2.2.4.3 Floor-Drain, Trap-Seal Primer Fittings:

Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.

- a. Size: Same as floor drain outlet with NPS 1/2 side inlet.

2.2.4.4 Air-Gap Fittings:

- a. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.

- b. Body: Bronze or cast iron.

- c. Inlet: Opening in top of body.

- d. Outlet: Larger than inlet.

- e. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.

2.2.4.5 Sleeve Flashing Device:

Manufactured, cast-iron fitting, with clamping device that forms sleeve for pipe floor penetrations of floor membrane. Include galvanized-steel pipe extension in top of fitting that will extend 1 inch above finished floor and galvanized-steel pipe extension in bottom of fitting that will extend through floor slab.

- a. Size: As required for close fit to riser or stack piping.

2.2.4.6 Expansion Joints:

- a. Standard: ASME A112.6.4.

- b. Body: Cast iron with bronze sleeve, packing, and gland.

- c. End Connections: Matching connected piping.

- d. Size: Same as connected soil, waste, or vent piping.

2.3 DRAIN ASSEMBLIES

Sanitary drains shall bear label, stamp, or other markings of specified testing agency. Comply with NSF 14 for plastic sanitary piping specialty components.

2.3.1 FLOOR DRAINS

2.3.1.1 Cast-Iron Floor Drains, FD-1:

- a. Standard: ASME A112.6.3.
- b. Pattern: Floor drain.
- c. Body Material: Gray iron.
- d. Seepage Flange: Required.
- e. Anchor Flange: Not required.
- f. Clamping Device: Not required.
- g. Outlet: Bottom.
- h. Coating on Interior and Exposed Exterior Surfaces: Acid Resistant, required.
- i. Sediment Bucket: Not required.
- j. Top or Strainer Material: Nickel Bronze.
- k. Top of Body and Strainer Finish: Cast Iron.
- l. Top Shape: Round.
- m. Dimensions of Top or Strainer: 8 1/2 inches.
- n. Top Loading Classification: Medium Duty.
- o. Outlet Fitting: Gray iron, with threaded, caulk or no-hub outlet, and trap-seal primer valve connection.
- p. Trap Material: Cast iron.
- q. Trap Pattern: Deep-seal P-Trap.
- r. Trap Features: Trap-seal primer valve drain connection.

2.3.1.2 Cast-Iron Floor Drains, FD-2:

- a. Standard: ASME A112.6.3.
- b. Pattern: Floor drain.
- c. Body Material: Gray iron.
- d. Seepage Flange: Required.
- e. Anchor Flange: Not required

- f. Clamping Device: Not required.
- g. Outlet: Bottom.
- h. Coating on Interior and Exposed Exterior Surfaces: Not required.
- i. Sediment Bucket: Not required.
- j. Top or Strainer Material: Nickel bronze.
- k. Top of Body and Strainer Finish: Nickel bronze.
- l. Top Shape: Round.
- m. Dimensions of Top or Strainer: 6 inches.
- n. Top Loading Classification: Medium Duty.
- o. Funnel: Not required.
- p. Inlet Fitting: Gray iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
- q. Trap Material: Cast iron.
- r. Trap Pattern: Standard P-trap.
- s. Trap Features: Trap-seal primer valve drain connection.

2.4 FLOOR SINKS

2.4.1 Floor Sink, FS-1

- a. Comply with ASME A112.21.1M.
- b. Body Material: Cast iron. White acid resistant porcelain enamel coating on interior surfaces only.
- c. Seepage Flange: Not required.
- d. Anchor Flange: Required.
- e. Dome Strainer: Required.
- f. Outlet: Bottom
- g. Top or Strainer Material: 1/2 Grate
- h. Top of Body and Strainer Finish: White acid resistant porcelain enamel.
- i. Top Shape: Square.
- j. Dimensions of Top or Strainer: 12 by 12 inches.
- k. Top Loading Classification: Medium Duty.
- l. Trap Material: Cast Iron.

- m. Trap Pattern: Deep-seal P-trap.
- n. Trap Features: Trap seal primer valve drain connection.

2.4.2 Floor Sink, FS-2:

Comply with ASME A112.21.1M.

- a. Body Material: Cast iron.
- b. Seepage Flange: Not Required.
- c. Anchor Flange: Required.
- d. Dome Strainer: Required.
- e. Outlet: Bottom.
- f. Top or Strainer Material: 1/2 Grate.
- g. Top of Body and Strainer Finish: Cast iron.
- h. Top Shape: Round.
- i. Dimensions of Top or Strainer: 8-1/2 inches.
- j. Top Loading Classification: Medium Duty.
- k. Trap Material: Cast iron.
- l. Trap Pattern: Deep-seal P-trap.
- m. Trap Features: Trap seal primer valve drain connection.

PART 3 EXECUTION

3.1 PREPARATION

Comply with requirements for excavating, trenching, and backfilling specified in on the Civil Drawings.

3.2 INSTALLATION

3.2.1 PIPING INSTALLATION

- a. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems.
 - (1) Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations.
 - (2) Install piping as indicated unless deviations to layout are approved on coordination drawings.
- b. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

- c. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- d. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal
- e. Install piping to permit valve servicing.
- f. Install piping at indicated slopes.
- g. Install piping free of sags and bends.
- h. Install fittings for changes in direction and branch connections.
- i. Install piping to allow application of insulation.
- j. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends.
 - (1) Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical.
 - (2) Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe.
 - a) Straight tees, elbows, and crosses may be used on vent lines.
 - (3) Do not change direction of flow more than 90 degrees.
 - (4) Use proper size of standard increasers and reducers if pipes of different sizes are connected.
 - a) Reducing size of waste piping in direction of flow is prohibited.
- k. Lay buried building waste piping beginning at low point of each system.
 - (1) Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream.
 - (2) Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
 - (3) Maintain swab in piping and pull past each joint as completed.
- l. Install soil and waste and vent piping at the following minimum slopes unless otherwise indicated:
 - (1) Building Sanitary Waste: 2 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
 - (2) Horizontal Sanitary Waste Piping: 2 percent downward in direction of flow.

- (3) Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.
 - m. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
 - (1) Install encasement on underground piping according to ASTM A674 or AWWA C105/A 21.5.
 - n. Install steel piping according to applicable plumbing code.
 - o. Install aboveground copper tubing according to CDA's "Copper Tube Handbook."
 - p. Install force mains at elevations indicated.
 - q. Plumbing Specialties:
 - (1) Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary waste gravity-flow piping.
 - a) Install cleanout fitting with closure plug inside the building in sanitary drainage force-main piping.
 - b) Comply with requirements for cleanouts specified in "Sanitary Waste Piping Specialties."
 - (2) Install drains in sanitary waste gravity-flow piping.
 - a) Comply with requirements for drains specified in "Sanitary Waste Piping Specialties."
 - r. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
 - s. Install sleeves for piping penetrations of walls, ceilings, and floors.
 - (1) Comply with requirements for sleeves specified in Section 22 00 00
 - t. Install sleeve seals for piping penetrations of concrete walls and slabs.
 - (1) Comply with requirements for sleeve seals specified in Section 22 00 00."
 - u. Install escutcheons for piping penetrations of walls, ceilings, and floors.
 - (1) Comply with requirements for escutcheons specified in Section 22 00 00.
- 3.2.2 JOINT CONSTRUCTION
- a. Join hub-and-spigot, cast-iron soil piping with gasket joints

according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

- b. Join hubless, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.
- c. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1.
 - (1) Cut threads full and clean using sharp dies.
 - (2) Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - a) Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 - b) Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
 - c) Do not use pipe sections that have cracked or open welds.
- d. Join copper tube and fittings with soldered joints according to ASTM B828. Use ASTM B813, water-flushable, lead-free flux and ASTM B32, lead-free-alloy solder.
- e. Grooved Joints: Cut groove ends of pipe according to AWWA C606. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections, over gasket, with keys seated in piping grooves. Install and tighten housing bolts.
- f. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.

3.2.3 SPECIALTY PIPE FITTING INSTALLATION

- a. Transition Couplings:
 - (1) Install transition couplings at joints of piping with small differences in ODs.
 - (2) In Waste Drainage Piping: Shielded, nonpressure transition couplings.
- b. Dielectric Fittings:
 - (1) Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
 - (2) Dielectric Fittings for NPS 2 and Smaller: Use dielectric unions.
 - (3) Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges.
 - (4) Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.2.4 HANGER AND SUPPORT INSTALLATION

- a. Comply with requirements for pipe hanger and support devices and installation specified in Section 22 00 00
 - (1) Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
 - (2) Install stainless-steel pipe hangers for horizontal piping in corrosive environments.
 - (3) Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
 - (4) Install stainless-steel pipe support clamps for vertical piping in corrosive environments.
 - (5) Vertical Piping: MSS Type 8 or Type 42, clamps.
 - (6) Install individual, straight, horizontal piping runs:
 - a) 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b) Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
 - c) Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.
 - (7) Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 - (8) Base of Vertical Piping: MSS Type 52, spring hangers.
- b. Support horizontal piping and tubing within 12 inches of each fitting, valve, and coupling.
- c. Support vertical piping and tubing at base and at each floor.
- d. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.
- e. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
 - (1) NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
 - (2) NPS 3: 60 inches with 1/2-inch rod.
 - (3) NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
 - (4) NPS 6 and NPS 8: 60 inches with 3/4-inch rod.
 - (5) NPS 10 and NPS 12: 60 inches with 7/8-inch rod.
 - (6) Spacing for 10-foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.
- f. Install supports for vertical cast-iron soil piping every 15 feet.

- g. Support piping and tubing not listed above according to MSS SP-58 and manufacturer's written instructions.

3.2.5 CONNECTIONS

- a. Drawings indicate general arrangement of piping, fittings, and specialties.
- b. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.
- c. Connect waste and vent piping to the following:
 - (1) Plumbing Fixtures: Connect waste piping in sizes indicated, but not smaller than required by plumbing code.
 - (2) Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
 - (3) Plumbing Specialties: Connect waste and vent piping in sizes indicated, but not smaller than required by plumbing code.
 - (4) Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
 - (5) Comply with requirements for cleanouts and drains specified in "Sanitary Waste Piping Specialties."
 - (6) Equipment: Connect waste piping as indicated.
 - a) Provide shutoff valve if indicated and union for each connection.
 - b) Use flanges instead of unions for connections NPS 2-1/2 and larger.
- d. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.
- e. Make connections according to the following unless otherwise indicated:
 - (1) Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
 - (2) Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.3 CLEANOUTS INSTALLATION

- a. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
 - (1) Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
 - (2) Locate at each change in direction of piping greater than 45

degrees.

(3) Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.

(4) Locate at base of each vertical soil and waste stack.

- b. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
- c. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
- d. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof. Comply with requirements in Section "Sheet Metal Flashing and Trim."
- e. Install deep-seal traps on floor drains and other waste outlets, if indicated.
- f. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.
 - (1) Exception: Fitting may be omitted if trap has trap-seal primer connection.
 - (2) Size: Same as floor drain inlet.
- g. Install sleeve and sleeve seals with each riser and stack passing through floors with waterproof membrane.
- h. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.
- i. Install wood-blocking reinforcement for wall-mounting-type specialties.
- j. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

3.4 DRAINS INSTALLATION

Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.

- a. Position floor drains for easy access and maintenance.
- b. Set floor drains below elevation of surrounding finished floor to allow floor drainage.
- c. Set with grates depressed according to the following drainage area radii:
 - (1) Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
 - (2) Radius, 30 to 60 Inches: Equivalent to 1 percent slope.

- (3) Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.
- d. Install floor-drain flashing collar or flange, so no leakage occurs between drain and adjoining flooring.
 - (1) Maintain integrity of waterproof membranes where penetrated.
- e. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

Install trench drains at low points of surface areas to be drained. Set grates of drains flush with finished surface, unless otherwise indicated.

Comply with ASME A112.3.1 for installation of stainless-steel channel drainage systems. Install on support devices, so that top will be flush with adjacent surface.

3.5 FIELD QUALITY CONTROL

3.5.1 Sanitary Waste and Vent Piping

- a. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
 - (1) Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
 - (2) Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- b. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
- c. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- d. Test sanitary waste and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
 - (1) Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired.
 - a) If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 - (2) Leave uncovered and unconcealed new, altered, extended, or replaced waste and vent piping until it has been tested and approved.
 - a) Expose work that was covered or concealed before it was tested.
 - (3) Roughing-in Plumbing Test Procedure: Test waste and vent piping

except outside leaders on completion of roughing-in.

- a) Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water.
 - b) From 15 minutes before inspection starts to completion of inspection, water level must not drop.
 - c) Inspect joints for leaks.
- (4) Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight.
- a) Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg.
 - b) Use U-tube or manometer inserted in trap of water closet to measure this pressure.
 - c) Air pressure must remain constant without introducing additional air throughout period of inspection.
 - d) Inspect plumbing fixture connections for gas and water leaks.
- (5) Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
- (6) Prepare reports for tests and required corrective action.

3.6 CLEANING AND PROTECTION

- a. Clean interior of piping. Remove dirt and debris as work progresses.
- b. Protect sanitary waste and vent piping, and drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- c. Place plugs in ends of uncompleted piping at end of day and when work stops.
- d. Repair damage to adjacent materials caused by waste and vent piping installation.

3.7 SCHEDULES

3.7.1 PIPING SCHEDULE

- a. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.
- b. Aboveground, soil and waste piping NPS 4 and smaller shall be any of the following:
 - (1) Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 - (2) Hubless, cast-iron soil pipe and fittings; heavy-duty

hubless-piping couplings; and coupled joints.

(3) Copper Type DWV tube, copper drainage fittings, and soldered joints.

(4) Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.

c. Aboveground, vent piping NPS 4 and smaller shall be the following:

(1) Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.

(2) Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.

(3) Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.

d. Underground, soil, waste, and vent piping NPS 4 and smaller shall be any of the following:

(1) Service class, cast-iron soil piping; gaskets; and gasketed joints.

(2) Hubless, cast-iron soil pipe and fittings; heavy-duty hubless-piping couplings; and coupled joints.

(3) Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.

-- End of Section --

SECTION 23 01 30.41

HVAC SYSTEM CLEANING
05/22

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 62.1 (2016) Ventilation for Acceptable Indoor Air Quality

INSTITUTE OF INSPECTION, CLEANING, AND RESTORATION CERTIFICATION (IICRC)

ANSI/IICRC S520 (2015) Standard and Reference Guide for Professional Mold Remediation

NATIONAL AIR DUCT CLEANERS ASSOCIATION (NADCA)

NADCA (2005) Introduction to HVAC System Cleaning Services

NADCA ACR (2013) Standard for Assessment, Cleaning, and Restoration of HVAC Systems

NADCA ASCS (2013) Air Systems Cleaning Specialist to the NADCA Standard ACR

NADCA HVAC Inspection Manual (2021) Procedures for Assessing the Cleanliness of Commercial HVAC Systems

NORTH AMERICAN INSULATION MANUFACTURERS ASSOCIATION (NAIMA)

NAIMA AH112 (1993) Cleaning Fibrous Glass or Lined Sheet Metal Ducts

NAIMA AH122 (2006) Cleaning Fibrous Insulated Duct Systems - Recommended Practices

NAIMA AH127 (1999) Facts About the Impact of Duct Cleaning on Internal Duct Insulation

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA 1966 (2020) HVAC Duct Construction Standards Metal and Flexible, 4th Edition

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1 (2014) Safety -- Safety and Health
Requirements Manual

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA 402-C-01-001 (2001) IAQ Building Education and
Assessment Tool (I-BEAM)

EPA 402-F-91-102 (1991) Building Air Quality: A Guide for
Building Owners and Facility Managers

UNDERWRITERS LABORATORIES (UL)

UL 181 (2013; Reprint Dec 2021) UL Standard for
Safety Factory-Made Air Ducts and Air
Connectors

UL 181A (2013; Reprint Dec 2021) Standard for
Safety Closure Systems for Use with Rigid
Air Ducts

UL 181B (2013; Reprint Dec 2021) UL Standard for
Safety Closure Systems for Use with
Flexible Air Ducts and Air Connectors

1.2 DEFINITIONS

1.2.1 NADCA Standards

Perform the services specified here in accordance with the current
published standards of the National Air Duct Cleaners Association (NADCA,
NADCA ASCS, NADCA ACR and NADCA HVAC Inspection Manual).

- a. All terms in this specification are defined as stated in the NADCA
Standards.
- b. Follow NADCA Standards without modification or deviation.

1.3 SUBMITTALS

Government approval is required for submittals. Submit the following in
accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Coordination Plan

NADCA Firm

NADCA Team Assistants

NADCA Air System Cleaning Specialist (ASCS)

NADCA Supervisor Qualifications

Records of Experience in the Field of HVAC System Cleaning

NADCA Work Execution Schedule

SD-03 Product Data

Safety Data Sheets (SDS)

SD-06 Test Reports

Testing Procedures Summary

Post-Project Report

1.4 QUALITY CONTROL

1.4.1 NADCA Firm

Submit information certifying that the NADCA firm is a first tier subcontractor who is not affiliated with any other company participating in work on this contract, including furnishing equipment. Further, submit the following, for the firm, to Contracting Officer for approval:

a. Independent NADCA firm:

NADCA Firm: NADCA registration number and expiration date of current certification;

NADCA Supervisor Qualifications: Name and copy of NADCA supervisor certificate and expiration date of current certification.

NADCA Air System Cleaning Specialist (ASCS): Name and documented evidence that the team field leader has satisfactorily performed full-time supervision of HVAC cleaning work in the field for not less than 3 years immediately preceding this contract's bid opening date.

NADCA Team Assistants: Names and documented evidence that each field technician has satisfactorily assisted a NADCA team field leader in performance of HVAC cleaning work in the field for not less than one year immediately preceding this contract's bid opening date.

Current Certificates: Ensure registrations and certifications are current, and valid for the duration of this contract. Renew Certifications which expire prior to completion of the HVAC cleaning work, in a timely manner so that there is no lapse in registration or certification. NADCA agency or NADCA team personnel without a current registration or current certification are not to perform HVAC cleaning work on this contract.

b. TAB Team Members: NADCA team approved to accomplish work on this contract are full-time employees of the NADCA firm. No other personnel is allowed to do HVAC cleaning work on this contract.

c. Replacement of NADCA Team Members: Replacement of members may occur if each new member complies with the applicable personnel qualifications and each is approved by the Contracting Officer.

1.4.2 Experience

Submit **records of experience in the field of HVAC system cleaning**. Bids will only be considered from firms which are regularly engaged in HVAC

system maintenance with an emphasis on HVAC system cleaning and decontamination.

1.4.3 Equipment, Materials and Labor

Possess and furnish all necessary equipment, materials and labor to adequately perform the specified services and comply with the applicable provisions of NADCA General Specifications for the Cleaning of Commercial HVAC Systems and [ASHRAE 62.1](#).

- a. Assure that all employees have received safety equipment training, medical surveillance programs, individual health protection measures, and manufacturer's product and Safety Data Sheets (SDS) as required for the work by the U.S. Occupational Safety and Health Administration, and as described by this specification. For work performed in countries outside of the U.S.A., comply with applicable national safety codes and standards.
- b. Maintain a copy of all current SDS documentation and safety certifications at the site at all times, as well as comply with all other site documentation requirements of applicable OSHA programs and this specification.
- c. Submit all [Safety Data Sheets \(SDS\)](#) for all chemical products proposed used in the cleaning process, including all VOC ratings.

1.4.4 Licensing

Provide proof of maintaining the proper license(s), if any, as required to do work in [the state of Alabama](#). Comply with all Federal, State and local rules, regulations, and licensing requirements.

1.4.5 Health And Safety

1.4.5.1 Safety Standards

Comply with all applicable Federal, State, and local requirements for protecting the safety of the contractors' employees, building occupants, and the environment. In particular, follow all applicable standards of the Occupational Safety and Health Administration (OSHA) when working in accordance with this specification, and [EM 385-1-1](#).

1.4.5.2 Occupant Safety

Employ no processes or materials in such a manner that introduce additional hazards into occupied spaces.

1.4.5.3 Disposal of Debris

Dispose of all debris removed from the HVAC System in accordance with applicable Federal, State and local requirements.

1.5 PROJECT/SITE CONDITIONS

1.5.1 Mechanical Drawings

Obtain one copy of the following documents:

- a. Project drawings and specifications

- b. Approved construction revisions pertaining to the HVAC system
- c. Any existing indoor air quality (IAQ) assessments or environmental reports prepared for the facility.

Submit a [NADCA Work Execution Schedule](#) to the Contracting Officer within 10 working days of the contract award.

1.5.2 Site Conditions

The HVAC system includes any interior surface of the facility's air distribution system for conditioned spaces and/or occupied zones. This includes the entire heating, air-conditioning and ventilation system from the points where the air enters the system to the points where the air is discharged from the system. The return air grilles, return air ducts (except ceiling plenums and mechanical room) to the air handling unit (AHU), the interior surfaces of the AHU, mixing box, coil compartment, condensate drain pans, humidifiers and dehumidifiers, supply air ducts, fans, fan housing, fan blades, air wash systems, spray eliminators, turning vanes, filters, filter housings, reheat coils, and supply diffusers are all considered part of the HVAC system. The HVAC system may also include other components such as dedicated exhaust and ventilation components and make-up air systems.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Perform the services specified here in accordance with the current published standards of the National Air Duct Cleaners Association ([NADCA](#), [NADCA ASCS](#), [NADCA ACR](#) and [NADCA HVAC Inspection Manual](#)).

- a. All terms in this specification have their meaning defined as stated in the NADCA Standards.
- b. Follow NADCA Standards with no modifications or deviations being allowed. Remove visible surface contaminants and deposits from within the HVAC system in strict accordance with these specifications.

3.1 PREPARATION

3.1.1 HVAC System Inspections And Site Preparations

3.1.1.1 HVAC System Evaluation

Prior to the commencement of any cleaning work, perform a visual inspection of the HVAC system in the presence of the Contracting Officer to determine appropriate methods, tools, and equipment required to satisfactorily complete this project. Cleanliness inspection should include air handling units and representative areas of HVAC system components and ductwork. In HVAC systems that include multiple air handling units, a representative sample of units should be inspected. Notify the Contracting Officer [10](#) days prior to the planned inspection. As part of evaluation, record photographs and videos of each inspection location to document the "as found" condition prior to cleaning.

3.1.1.2 Site Evaluation and Preparations

Conduct without negatively impacting indoor environment through excessive disruption of settled dust, microbial amplification or other debris. In cases where contamination is suspected, and/or in sensitive environments where even small amounts of contaminant may be of concern, implement environmental engineering control measures.

Conduct a site evaluation, and establish a specific, [coordination plan](#) which details how each area of the building is protected during the various phases of the project.

3.2 APPLICATION

3.2.1 General HVAC System Cleaning Requirements

3.2.1.1 Containment

Collect debris removed during cleaning and take precautions to ensure that debris is not otherwise dispersed outside the HVAC system during the cleaning process.

3.2.1.2 Particulate Collection

Where the Particulate Collection Equipment (PCE) is exhausting inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron size (or greater). When the PCE is exhausting outside the building, undertake mechanical cleaning operations only with PCE, including adequate filtration to contain debris removed from the HVAC system. When the PCE is exhausting outside the building, take precautions to locate the equipment down wind and away from all air intakes and other points of entry into the building.

3.2.1.3 Controlling Odors

Take all reasonable measures to control offensive odors and/or mist vapors during the cleaning process.

3.2.1.4 Component Cleaning

Employ cleaning methods such that all HVAC system components are Visibly Clean as defined in applicable standards. Upon completion, return all components to those settings recorded just prior to cleaning operations.

3.2.1.5 Air-Volume Control Devices

Mark the position of dampers and any air-directional mechanical devices inside the HVAC system prior to cleaning and, upon completion, restore to their marked position.

3.2.1.6 Service Openings

Utilize service openings, as required for proper cleaning, at various points of the HVAC system for physical and mechanical entry, and inspection. Utilize the existing service openings already installed in the HVAC system where possible.

Create other openings where needed, created and resealed in conformance with NADCA Standard 05. Place closures so they do not significantly

hinder, restrict, alter the air-flow within the system, or compromise the structural integrity of the system. Properly insulate closures to prevent heat loss/gain or condensation on surfaces within the system. Conform construction techniques used in the creation of openings to requirements of applicable building and fire codes, and applicable NFPA, SMACNA and NADCA Standards. Cutting service openings into flexible duct is not permitted. Disconnect flexible duct at the ends as needed for proper cleaning and inspection.

Reseal rigid fiber glass ductboard duct systems in accordance with NAIMA recommended practices; [NAIMA AH112](#), [NAIMA AH122](#), and [NAIMA AH127](#). Only closure techniques which comply with [UL 181](#), [UL 181A](#), or [UL 181B](#) are suitable for fiber glass duct system closures.

Provide access doors for openings that need to be re-opened for future inspection or remediation. Refer to Section [23 31 13.00 40](#) - Metal Ducts for access doors. Clearly mark all service openings, capable of being re-opened for future inspection or remediation, and report their location in project report documents.

3.2.1.7 Ceiling Sections (Tile)

Carefully remove and reinstall ceiling sections to gain access to HVAC systems during the cleaning process. Replace any damaged ceiling sections caused by the removal at no cost to the Government.

3.2.1.8 Air Distribution Devices (Registers, Grilles and Diffusers)

Clean all air distribution devices.

3.2.1.9 Air Handling Units, Terminal Units, Blowers and Exhaust Fans

Ensure that supply, return, and exhaust fans and blowers are thoroughly cleaned. Areas for cleaning include blowers, fan housings, plenums (except ceiling supply and return plenums), scrolls, blades, or vanes, shafts, baffles, dampers and drive assemblies. Remove all visible surface contamination deposits in accordance with NADCA Standards.

- a. Clean all air handling unit (AHU) internal surfaces, components and condensate collectors and drains.
- b. Assure that a suitable operative drainage system is in place prior to beginning wash down procedures.
- c. Clean all coils and related components, including evaporator fins.

3.2.1.10 Duct Systems

- a. Create service openings in the system as necessary in order to accommodate cleaning of otherwise inaccessible areas.
- b. Mechanically clean all duct systems to remove all visible contaminants, such that the systems are capable of passing NADCA Cleaning Verification Testings Standards.
- c. Any exposed edges in internal duct lining within duct, including but not limited to interfaces with externally insulated duct, must be fully protected, sealed and encapsulated to prevent future erosion.

3.2.2 Mechanical Cleaning Methodology

3.2.2.1 Source Removal Cleaning Methods

Clean the HVAC system using Source Removal mechanical cleaning methods designed to extract contaminants from within the HVAC system and safely remove contaminants from the facility. Select Source Removal methods which will render the HVAC System Visibly Clean and capable of passing NADCA cleaning verification methods Standards and other specified standards and tests, in accordance with all general requirements. Use no cleaning method, or combination of methods, which could potentially damage components of the HVAC system or negatively alter the integrity of the system.

Incorporate the use of vacuum collection devices that are operated continuously during cleaning for all methods used. Connect a vacuum device to the downstream end of the section being cleaned through a predetermined opening. Use a vacuum collection device of sufficient power to render all areas being cleaned under negative pressure, such that containment of debris and the protection of the indoor environment is assured.

Equip all vacuum devices exhausting air inside the building, including hand-held vacuums and wet-vacuums, with HEPA filters (minimum efficiency).

Equip all vacuum devices exhausting air outside the facility with Particulate Collection including adequate filtration to contain Debris removed from the HVAC system, in a manner that does not allow contaminants to re-enter the facility. Release of debris outdoors which violates any outdoor environmental standards, codes or regulations is not allowed.

All methods require mechanical agitation devices to dislodge debris adhered to interior HVAC system surfaces, such that debris may be safely conveyed to vacuum collection devices. Acceptable methods include those which will not potentially damage the integrity of the ductwork, nor damage porous surface materials such as liners inside the ductwork or system components.

3.2.2.2 Methods of Cleaning Fibrous Glass Insulated Components

Thoroughly clean glass **thermal and acoustical** insulation elements present in any equipment or ductwork with HEPA vacuuming equipment. Clean while the HVAC system is under constant negative pressure, and not permitted to get wet in accordance with applicable NADCA and NAIMA standards and recommendations.

Do not use cleaning methods that cause damage to fibrous glass components or renders the system capable of passing Cleaning Verification Tests NADCA Standards.

Provide surface treatment for insulation for sections of internally-lined duct. Select and apply encapsulants, coatings, and insulation repair products to completely restore surface integrity of fibrous glass surfaces in accordance with applicable standards and manufacturer's installation instructions.

3.2.2.3 Damaged Fibrous Glass Material

If there is any evidence of damage, deterioration, delamination, friable

material, mold or fungus growth, or moisture such that fibrous glass materials cannot be restored by cleaning or resurfacing with an acceptable insulation repair coating, identify them to the Contracting Officer for replacement.

When requested or specified, remediate exposed damaged insulation in air handlers and/or ductwork requiring replacement.

If insulation is damaged as a result of this work under this specification, notify Contracting Officer and initiate a meeting with same to determine options for repair or replacement of insulation.

3.2.2.4 Replacement Material

If replacement of fiber glass materials is required, conform all materials to applicable industry codes and standards, including those of UL and [SMACNA 1966](#).

Replacement of damaged insulation is **not** covered by this specification. Refer to Section [23 07 00](#) - Thermal Insulation for Mechanical Systems.

3.2.2.5 Cleaning of Coils

Use any cleaning method which renders the coil visibly clean and capable of passing NADCA Coil Cleaning Verification Standards. Coil drain pans are subject to Non-Porous Surfaces Cleaning Verification. Maintain operability of the drain for the condensate at all times. Do not damage, displace, inhibit heat transfer, or cause erosion of the coil surface or fins, and conform to coil manufacturer recommendations when available. Thoroughly rinse coils with clean water to remove any latent residues.

3.2.2.6 Antimicrobial Agents and Coatings

Perform application of antimicrobial agents used to control the growth of fungal or bacteriological contaminants after the removal of surface deposits and debris. Perform mold remediation in accordance with [ANSI/IICRC S520](#).

Use only antimicrobial agents registered by the U.S. Environmental Protection Agency ([EPA 402-F-91-102](#))([EPA 402-C-01-001](#)) specifically for use within HVAC system.

Apply antimicrobial agents in strict accordance with manufacturer's instructions.

Use only antimicrobial coating products, for both porous and non-porous surfaces, which are EPA registered, water soluble solutions with supporting efficacy data and SDS records.

Apply antimicrobial coatings according to manufacturer's instructions. Spray coatings directly onto interior ductwork surfaces, rather than "fog" downstream onto surfaces. Achieve a continuous film on the surface treated by the coating application, and apply in strict accordance with manufacturer's minimum millage surface application rate standards for effectiveness.

3.3 FIELD QUALITY CONTROL

3.3.1 CLEANLINESS VERIFICATION

3.3.1.1 General

Verification of HVAC System cleanliness is determined after mechanical cleaning and before the application of any treatment or introduction of any treatment-related substance to the HVAC system, including antimicrobial agents and coatings.

3.3.1.2 Visual Inspection

Visually inspect the HVAC system to ensure that no visible contaminants are present.

If no contaminants are evident through visual inspection, consider the HVAC system clean; however, further verification of the system cleanliness through gravimetric or wipe testing analysis testing may be requested at the discretion of the Contracting Officer.

If visible contaminants are evident through visual inspection, re-clean those portions of the system where contaminants are visible, and subject to re-inspection for cleanliness.

As part of inspection, record photographs and videos of inspection locations to document post-cleaning condition.

3.3.1.3 Verification of Coil Cleaning

Cleaning is to restore the coil pressure drop to within 10 percent of the pressure drop measured when the coil was first installed. If the original pressure drop is not known, the coil will be considered clean only if the coil is free of foreign matter and chemical residue, based on a thorough visual inspection (see [NADCA HVAC Inspection Manual](#) Standards).

3.3.2 Post-Project Report

At the conclusion of the project, provide a [Testing Procedures Summary](#) and [Post-Project Report](#) indicating the following:

- a. Success of the cleaning project, as verified through visual inspection.
- b. Areas of the system found to be damaged and/or in need of repair.

-- End of Section --

SECTION 23 03 00.00 20

BASIC MECHANICAL MATERIALS AND METHODS
08/10, CHG 3: 08/18

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM B117 (2019) Standard Practice for Operating
Salt Spray (Fog) Apparatus

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2 (2023) National Electrical Safety Code

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1 (2021) Motors and Generators

NEMA MG 10 (2017) Energy Management Guide for
Selection and Use of Fixed Frequency
Medium AC Squirrel-Cage Polyphase
Induction Motors

NEMA MG 11 (1977; R 2012) Energy Management Guide for
Selection and Use of Single Phase Motors

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (2023) National Electrical Code

1.2 RELATED REQUIREMENTS

This section applies to all sections of Divisions: 21, FIRE SUPPRESSION; 22, PLUMBING; and 23, HEATING, VENTILATING, AND AIR CONDITIONING of this project specification, unless specified otherwise in the individual section.

1.3 QUALITY ASSURANCE

1.3.1 Material and Equipment Qualifications

Provide materials and equipment that are standard products of manufacturers regularly engaged in the manufacture of such products, which are of a similar material, design and workmanship. Standard products must have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year use must include applications of equipment and materials under similar circumstances and of similar size. The product must have been for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2 year period.

1.3.2 Alternative Qualifications

Products having less than a two-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturer's factory or laboratory tests, can be shown.

1.3.3 Service Support

The equipment items must be supported by service organizations. Submit a certified list of qualified permanent service organizations for support of the equipment which includes their addresses and qualifications. These service organizations must be reasonably convenient to the equipment installation and able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

1.3.4 Manufacturer's Nameplate

For each item of equipment, provide a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

1.3.5 Modification of References

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "must" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction", or words of similar meaning, to mean the Contracting Officer.

1.3.5.1 Definitions

For the International Code Council (ICC) Codes referenced in the contract documents, advisory provisions must be considered mandatory, the word "should" is interpreted as "must." Reference to the "code official" must be interpreted to mean the "Contracting Officer." For Navy owned property, references to the "owner" must be interpreted to mean the "Contracting Officer." For leased facilities, references to the "owner" must be interpreted to mean the "lessor." References to the "permit holder" must be interpreted to mean the "Contractor."

1.3.5.2 Administrative Interpretations

For ICC Codes referenced in the contract documents, the provisions of Chapter 1, "Administrator," do not apply. These administrative requirements are covered by the applicable Federal Acquisition Regulations (FAR) included in this contract and by the authority granted to the Officer in Charge of Construction to administer the construction of this project. References in the ICC Codes to sections of Chapter 1, must be applied appropriately by the Contracting Officer as authorized by his administrative cognizance and the FAR.

1.4 DELIVERY, STORAGE, AND HANDLING

Handle, store, and protect equipment and materials to prevent damage before and during installation in accordance with the manufacturer's recommendations, and as approved by the Contracting Officer. Replace damaged or defective items.

1.5 ELECTRICAL REQUIREMENTS

Furnish motors, controllers, disconnects and contactors with their respective pieces of equipment. Motors, controllers, disconnects and contactors must conform to and have electrical connections provided under Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Furnish internal wiring for components of packaged equipment as an integral part of the equipment. Extended voltage range motors will not be permitted. Controllers and contactors shall have a maximum of 120 volt control circuits, and must have auxiliary contacts for use with the controls furnished. When motors and equipment furnished are larger than sizes indicated, the cost of additional electrical service and related work must be included under the section that specified that motor or equipment. Power wiring and conduit for field installed equipment must be provided under and conform to the requirements of Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

1.6 ELECTRICAL INSTALLATION REQUIREMENTS

Electrical installations must conform to IEEE C2, NFPA 70, and requirements specified herein.

1.6.1 New Work

Provide electrical components of mechanical equipment, such as motors, motor starters, control or push-button stations, float or pressure switches, solenoid valves, integral disconnects, and other devices functioning to control mechanical equipment, as well as control wiring and conduit for circuits rated 100 volts or less, to conform with the requirements of the section covering the mechanical equipment. Extended voltage range motors are not to be permitted. The interconnecting power wiring and conduit, control wiring rated 120 volts (nominal) and conduit, and the electrical power circuits must be provided under Division 26, except internal wiring for components of package equipment must be provided as an integral part of the equipment. When motors and equipment furnished are larger than sizes indicated, provide any required changes to the electrical service as may be necessary and related work as a part of the work for the section specifying that motor or equipment.

1.6.2 Modifications to Existing Systems

Where existing mechanical systems and motor-operated equipment require modifications, provide electrical components under Division 26.

1.6.3 High Efficiency Motors

1.6.3.1 High Efficiency Single-Phase Motors

Unless otherwise specified, single-phase fractional-horsepower alternating-current motors must be high efficiency types corresponding to the applications listed in NEMA MG 11.

1.6.3.2 High Efficiency Polyphase Motors

Unless otherwise specified, polyphase motors must be selected based on high efficiency characteristics relative to the applications as listed in NEMA MG 10. Additionally, polyphase squirrel-cage medium induction motors with continuous ratings must meet or exceed energy efficient ratings in accordance with Table 12-6C of NEMA MG 1.

1.6.4 Three-Phase Motor Protection

Provide controllers for motors rated one 1 horsepower and larger with electronic phase-voltage monitors designed to protect motors from phase-loss, undervoltage, and overvoltage. Provide protection for motors from immediate restart by a time adjustable restart relay.

1.7 INSTRUCTION TO GOVERNMENT PERSONNEL

When specified in other sections, furnish the services of competent instructors to give full instruction to the designated Government personnel in the adjustment, operation, and maintenance, including pertinent safety requirements, of the specified equipment or system. Instructors must be thoroughly familiar with all parts of the installation and must be trained in operating theory as well as practical operation and maintenance work.

Instruction must be given during the first regular work week after the equipment or system has been accepted and turned over to the Government for regular operation. The number of man-days (8 hours per day) of instruction furnished must be as specified in the individual section. When more than 4 man-days of instruction are specified, use approximately half of the time for classroom instruction. Use other time for instruction with the equipment or system.

When significant changes or modifications in the equipment or system are made under the terms of the contract, provide additional instruction to acquaint the operating personnel with the changes or modifications.

1.8 ACCESSIBILITY

Install all work so that parts requiring periodic inspection, operation, maintenance, and repair are readily accessible. Install concealed valves, expansion joints, controls, dampers, and equipment requiring access, in locations freely accessible through access doors.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.1 PAINTING OF NEW EQUIPMENT

New equipment painting must be factory applied or shop applied, and must be as specified herein, and provided under each individual section.

3.1.1 Factory Painting Systems

Manufacturer's standard factory painting systems may be provided subject to certification that the factory painting system applied will withstand 125 hours in a salt-spray fog test, except that equipment located outdoors must withstand 500 hours in a salt-spray fog test. Salt-spray fog test must be in accordance with ASTM B117, and for that test the acceptance criteria must be as follows: immediately after completion of the test, the paint must show no signs of blistering, wrinkling, or cracking, and no loss of adhesion; and the specimen must show no signs of rust creepage beyond 0.125 inch on either side of the scratch mark.

The film thickness of the factory painting system applied on the equipment must not be less than the film thickness used on the test specimen. If manufacturer's standard factory painting system is being proposed for use on surfaces subject to temperatures above 120 degrees F, the factory painting system must be designed for the temperature service.

3.1.2 Shop Painting Systems for Metal Surfaces

Clean, pretreat, prime and paint metal surfaces; except aluminum surfaces need not be painted. Apply coatings to clean dry surfaces. Clean the surfaces to remove dust, dirt, rust, oil and grease by wire brushing and solvent degreasing prior to application of paint, except metal surfaces subject to temperatures in excess of 120 degrees F must be cleaned to bare metal.

Where more than one coat of paint is specified, apply the second coat after the preceding coat is thoroughly dry. Lightly sand damaged painting and retouch before applying the succeeding coat. Color of finish coat must be aluminum or light gray.

- a. Temperatures Less Than 120 Degrees F: Immediately after cleaning, the metal surfaces subject to temperatures less than 120 degrees F must receive one coat of pretreatment primer applied to a minimum dry film thickness of 0.3 mil, one coat of primer applied to a minimum dry film thickness of 1 mil; and two coats of enamel applied to a minimum dry film thickness of 1 mil per coat.
- b. Temperatures Between 120 and 400 Degrees F: Metal surfaces subject to temperatures between 120 and 400 degrees F must receive two coats of 400 degrees F heat-resisting enamel applied to a total minimum thickness of 2 mils.
- c. Temperatures Greater Than 400 Degrees F: Metal surfaces subject to temperatures greater than 400 degrees F must receive two coats of 600 degrees F heat-resisting paint applied to a total minimum dry film thickness of 2 mils.

-- End of Section --

SECTION 23 05 15

COMMON PIPING FOR HVAC
05/22

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 325 (2017) Steel Construction Manual

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME A112.19.2/CSA B45.1 (2018; ERTA 2018) Standard for Vitreous China Plumbing Fixtures and Hydraulic Requirements for Water Closets and Urinals

ASME B16.1 (2020) Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250

ASME B16.3 (2021) Malleable Iron Threaded Fittings, Classes 150 and 300

ASME B16.4 (2021) Gray Iron Threaded Fittings; Classes 125 and 250

ASME B16.5 (2020) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard

ASME B16.9 (2018) Factory-Made Wrought Buttwelding Fittings

ASME B16.11 (2022) Forged Fittings, Socket-Welding and Threaded

ASME B16.22 (2021) Wrought Copper and Copper Alloy Solder Joint Pressure Fittings

ASME B16.25 (2017) Buttwelding Ends

ASME B16.34 (2021) Valves - Flanged, Threaded and Welding End

ASME B31.3 (2020) Process Piping

ASME B36.10M (2022) Welded and Seamless Wrought Steel Pipe

ASME B40.100 (2013) Pressure Gauges and Gauge Attachments

ASME BPVC SEC IX (2017; Errata 2018) BPVC Section

IX-Welding, Brazing and Fusing
Qualifications

ASME BPVC SEC VIII D1

(2019) BPVC Section VIII-Rules for
Construction of Pressure Vessels Division 1

AMERICAN WELDING SOCIETY (AWS)

AWS A5.8/A5.8M

(2019) Specification for Filler Metals for
Brazing and Braze Welding

AWS WHB-2.9

(2004) Welding Handbook; Volume 2, Welding
Processes, Part 1

ASTM INTERNATIONAL (ASTM)

ASTM A6/A6M

(2021) Standard Specification for General
Requirements for Rolled Structural Steel
Bars, Plates, Shapes, and Sheet Piling

ASTM A53/A53M

(2022) Standard Specification for Pipe,
Steel, Black and Hot-Dipped, Zinc-Coated,
Welded and Seamless

ASTM A105/A105M

(2021) Standard Specification for Carbon
Steel Forgings for Piping Applications

ASTM A126

(2004; R 2019) Standard Specification for
Gray Iron Castings for Valves, Flanges,
and Pipe Fittings

ASTM A197/A197M

(2000; R 2019) Standard Specification for
Cupola Malleable Iron

ASTM A234/A234M

(2022) Standard Specification for Piping
Fittings of Wrought Carbon Steel and Alloy
Steel for Moderate and High Temperature
Service

ASTM A276/A276M

(2017) Standard Specification for
Stainless Steel Bars and Shapes

ASTM A307

(2021) Standard Specification for Carbon
Steel Bolts, Studs, and Threaded Rod 60
000 PSI Tensile Strength

ASTM A563

(2021; E 2022a) Standard Specification for
Carbon and Alloy Steel Nuts

ASTM B32

(2020) Standard Specification for Solder
Metal

ASTM B62

(2017) Standard Specification for
Composition Bronze or Ounce Metal Castings

ASTM B88

(2022) Standard Specification for Seamless
Copper Water Tube

ASTM B117

(2019) Standard Practice for Operating

Salt Spray (Fog) Apparatus

ASTM B370	(2022) Standard Specification for Copper Sheet and Strip for Building Construction
ASTM B749	(2020) Standard Specification for Lead and Lead Alloy Strip, Sheet and Plate Products
ASTM C67/C67M	(2021) Standard Test Methods for Sampling and Testing Brick and Structural Clay Tile
ASTM C109/C109M	(2021) Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or (50-mm) Cube Specimens)
ASTM C404	(2018) Standard Specification for Aggregates for Masonry Grout
ASTM C476	(2022) Standard Specification for Grout for Masonry
ASTM C553	(2013; R 2019) Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications
ASTM C920	(2018) Standard Specification for Elastomeric Joint Sealants
ASTM E1	(2014) Standard Specification for ASTM Liquid-in-Glass Thermometers
ASTM E814	(2013a; R 2017) Standard Test Method for Fire Tests of Penetration Firestop Systems
ASTM F104	(2011; R 2020) Standard Classification System for Nonmetallic Gasket Materials
ASTM F2389	(2021) Standard Specification for Pressure-rated Polypropylene (PP) Piping Systems

FLUID SEALING ASSOCIATION (FSA)

FSA-0017	(1995e6) Standard for Non-Metallic Expansion Joints and Flexible Pipe Connectors Technical Handbook

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2	(2023) National Electrical Safety Code

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-58	(2018) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation

MSS SP-67	(2022) Butterfly Valves
MSS SP-70	(2011) Gray Iron Gate Valves, Flanged and Threaded Ends
MSS SP-72	(2010a) Ball Valves with Flanged or Butt-Welding Ends for General Service
MSS SP-80	(2019) Bronze Gate, Globe, Angle and Check Valves
MSS SP-110	(2010) Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends
MSS SP-125	(2010) Gray Iron and Ductile Iron In-Line, Spring-Loaded, Center-Guided Check Valves

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(2021) Motors and Generators
NEMA MG 10	(2017) Energy Management Guide for Selection and Use of Fixed Frequency Medium AC Squirrel-Cage Polyphase Induction Motors
NEMA MG 11	(1977; R 2012) Energy Management Guide for Selection and Use of Single Phase Motors

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023) National Electrical Code

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-C-18480	(1982; Rev B; Notice 2 2009; Notice 3 2022) Coating Compound, Bituminous, Solvent, Coal-Tar Base

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

CID A-A-1922	(Rev A; Notice 3) Shield, Expansion (Caulking Anchors, Single Lead)
CID A-A-1923	(Rev A; Notice 3) Shield, Expansion (Lag, Machine and Externally Threaded Wedge Bolt Anchors)
CID A-A-1924	(Rev A; Notice 3) Shield, Expansion (Self Drilling Tubular Expansion Shell Bolt Anchors)
CID A-A-1925	(Rev A; Notice 3) Shield Expansion (Nail Anchors)
CID A-A-55614	(Basic; Notice 2) Shield, Expansion (Non-Drilling Expansion Anchors)

CID A-A-55615

(Basic; Notice 3) Shield, Expansion (Wood
Screw and Lag Bolt Self-Threading Anchors

UNDERWRITERS LABORATORIES (UL)

UL 1479

(2015; Reprint May 2021) Fire Tests of
Through-Penetration Firestops

1.2 GENERAL REQUIREMENTS

Section 23 30 00 HVAC AIR DISTRIBUTION applies to work specified in this section

Submit [Records of Existing Conditions](#) consisting of the results of Contractor's survey of work area conditions and features of existing structures and facilities within and adjacent to the jobsite. Commencement of work constitutes acceptance of the existing conditions.

Include with [Equipment Foundation Data](#) for piping systems all plan dimensions of foundations and relative elevations, equipment weight and operating loads, horizontal and vertical loads, horizontal and vertical clearances for installation, and size and location of anchor bolts.

Submit [Fabrication Drawings](#) for pipes, valves and specialties consisting of fabrication and assembly details to be performed in the factory.

Submit [Material, Equipment, and Fixture Lists](#) for pipes, valves and specialties including manufacturer's style or catalog numbers, specification and drawing reference numbers, warranty information, and fabrication site information. Provide a complete list of construction equipment to be used.

Submit [Manufacturer's Standard Color Charts](#) for pipes, valves and specialties showing the manufacturer's recommended color and finish selections.

Include with [Listing of Product Installations](#) for piping systems identification of at least 5 units, similar to those proposed for use, that have been in successful service for a minimum period of 5 years. Include in the list purchaser, address of installation, service organization, and date of installation.

Submit [Record Drawings](#) for pipes, valves and accessories providing current factual information including deviations and amendments to the drawings, and concealed and visible changes in the work.

Submit [Connection Diagrams](#) for pipes, valves and specialties indicating the relations and connections of devices and apparatus by showing the general physical layout of all controls, the interconnection of one system (or portion of system) with another, and internal tubing, wiring, and other devices.

Submit [Coordination Drawings](#) for pipes, valves and specialties showing

coordination of work between different trades and with the structural and architectural elements of work. Detail all drawings sufficiently to show overall dimensions of related items, clearances, and relative locations of work in allotted spaces. Indicate on drawings where conflicts or clearance problems exist between various trades.

1.3 SUBMITTALS

Government approval is required for submittals. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

- Material, Equipment, and Fixture Lists

SD-02 Shop Drawings

- Record Drawings

- Connection Diagrams

- Coordination Drawings

- Fabrication Drawings

- Installation Drawings

SD-03 Product Data

- Pipe and Fittings

- Piping Specialties

- Valves

- Miscellaneous Materials

- Supporting Elements

- Equipment Foundation Data

SD-04 Samples

- Manufacturer's Standard Color Charts

SD-05 Design Data

- Pipe and Fittings

- Piping Specialties

- Valves

SD-06 Test Reports

- Hydrostatic Tests

- Air Tests

Valve-Operating Tests

Drainage Tests

Pneumatic Tests

Non-Destructive Electric Tests

System Operation Tests

SD-07 Certificates

Record of Satisfactory Field Operation

List of Qualified Permanent Service Organizations

Listing of Product Installations

Records of Existing Conditions

Surface Resistance

Shear and Tensile Strengths

Temperature Ratings

Bending Tests

Flattening Tests

Transverse Guided Weld Bend Tests

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals

1.4 QUALITY ASSURANCE

1.4.1 Material and Equipment Qualifications

Provide materials and equipment that are standard products of manufacturers regularly engaged in the manufacture of such products, which are of a similar material, design and workmanship. Provide standard products in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year use includes applications of equipment and materials under similar circumstances and of similar size. Ensure the product has been for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2 year period.

1.4.2 Alternative Qualifications

Products having less than a two-year field service record are acceptable if a certified [record of satisfactory field operation](#) for not less than 6000 hours, exclusive of the manufacturer's factory or laboratory tests, can be shown.

1.4.3 Service Support

Ensure the equipment items are supported by service organizations. Submit

a certified [list of qualified permanent service organizations](#) for support of the equipment which includes their addresses and qualifications. Select service organizations that are reasonably convenient to the equipment installation and able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

1.4.4 Manufacturer's Nameplate

Provide a nameplate on each item of equipment bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent is not acceptable.

1.4.5 Modification of References

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer.

1.4.5.1 Definitions

For the International Code Council (ICC) Codes referenced in the contract documents, advisory provisions are considered mandatory, the word "should" is interpreted as "shall." Reference to the "code official" is interpreted to mean the "Contracting Officer." For Navy owned property, interpret references to the "owner" to mean the "Contracting Officer." For leased facilities, references to the "owner" is interpreted to mean the "lessor." References to the "permit holder" are interpreted to mean the "Contractor."

1.4.5.2 Administrative Interpretations

For ICC Codes referenced in the contract documents, the provisions of Chapter 1, "Administrator," do not apply. These administrative requirements are covered by the applicable Federal Acquisition Regulations (FAR) included in this contract and by the authority granted to the Officer in Charge of Construction to administer the construction of this project. References in the ICC Codes to sections of Chapter 1, are applied as appropriate by the Contracting Officer and as authorized by his administrative cognizance and the FAR.

1.5 DELIVERY, STORAGE, AND HANDLING

Handle, store, and protect equipment and materials to prevent damage before and during installation in accordance with the manufacturer's recommendations, and as approved by the Contracting Officer. Replace damaged or defective items.

1.6 ELECTRICAL REQUIREMENTS

Furnish motors, controllers, disconnects and contactors with their respective pieces of equipment. Ensure motors, controllers, disconnects and contactors conform to and have electrical connections provided under Section [26 20 00](#) INTERIOR DISTRIBUTION SYSTEM. Furnish internal wiring for components of packaged equipment as an integral part of the equipment.

Extended voltage range motors is not permitted. Provide controllers and contactors with a maximum of 120 volt control circuits, and auxiliary contacts for use with the controls furnished. When motors and equipment furnished are larger than sizes indicated, include the cost of additional electrical service and related work under the section that specified that motor or equipment. Provide power wiring and conduit for field installed equipment under and conform to the requirements of Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

1.7 ELECTRICAL INSTALLATION REQUIREMENTS

Ensure electrical installations conform to IEEE C2, NFPA 70, and requirements specified herein.

1.7.1 New Work

Provide electrical components of mechanical equipment, such as motors, motor starters, control or push-button stations, float or pressure switches, solenoid valves, integral disconnects, and other devices functioning to control mechanical equipment, as well as control wiring and conduit for circuits rated 100 volts or less, to conform with the requirements of the section covering the mechanical equipment. Extended voltage range motors are not permitted. Provide under Division 26, the interconnecting power wiring and conduit, control wiring rated 120 volts (nominal) and conduit, and the electrical power circuits, except internal wiring for components of package equipment is provided as an integral part of the equipment. When motors and equipment furnished are larger than sizes indicated, provide any required changes to the electrical service as may be necessary and related work as a part of the work for the section specifying that motor or equipment.

1.7.2 Modifications to Existing Systems

Where existing mechanical systems and motor-operated equipment require modifications, provide electrical components under Division 26.

1.7.3 High Efficiency Motors

1.7.3.1 High Efficiency Single-Phase Motors

Unless otherwise specified, provide high efficiency single-phase fractional-horsepower alternating-current motors corresponding to the applications listed in NEMA MG 11.

1.7.3.2 High Efficiency Polyphase Motors

Unless otherwise specified, select polyphase motors based on high efficiency characteristics relative to the applications as listed in NEMA MG 10. Additionally, ensure polyphase squirrel-cage medium induction motors with continuous ratings meet or exceed energy efficient ratings in accordance with Table 12-6C of NEMA MG 1.

1.7.4 Three-Phase Motor Protection

Provide controllers for motors rated one horsepower and larger with electronic phase-voltage monitors designed to protect motors from phase-loss, undervoltage, and overvoltage. Provide protection for motors from immediate restart by a time adjustable restart relay.

1.8 INSTRUCTION TO GOVERNMENT PERSONNEL

When specified in other sections, furnish the services of competent instructors to give full instruction to the designated Government personnel in the adjustment, operation, and maintenance, including pertinent safety requirements, of the specified equipment or system. Provide instructors thoroughly familiar with all parts of the installation and trained in operating theory as well as practical operation and maintenance work.

Give instruction during the first regular work week after the equipment or system has been accepted and turned over to the Government for regular operation. The number of man-days (8 hours per day) of instruction furnished is as specified in the individual section. When more than 4 man-days of instruction are specified, use approximately half of the time for classroom instruction. Use other time for instruction with the equipment or system.

When significant changes or modifications in the equipment or system are made under the terms of the contract, provide additional instruction to acquaint the operating personnel with the changes or modifications.

1.9 ACCESSIBILITY

Install all work so that parts requiring periodic inspection, operation, maintenance, and repair are readily accessible. Install concealed valves, expansion joints, controls, dampers, and equipment requiring access, in locations freely accessible through access doors.

PART 2 PRODUCTS

2.1 PIPE AND FITTINGS

Submit equipment and performance data for [pipe and fittings](#) consisting of corrosion resistance, life expectancy, gage tolerances, and grade line analysis. Submit design analysis and calculations consisting of surface resistance, rates of flow, head losses, inlet and outlet design, required radius of bend, and pressure calculations. Also include in data pipe size, shape, and dimensions, as well as temperature ratings, vibration and thrust limitations minimum burst pressures, shut-off and non-shock pressures and weld characteristics.

2.1.1 Type BCS-125, [125-psi Service](#)

Ensure pipe [2 through 10 inches](#) is Schedule 40 steam, Schedule 80 condensate, seamless or electric-resistance welded black carbon steel, conforming to [ASTM A53/A53M](#) Type S (seamless) and [ASME B36.10M](#).

Ensure pipe [12 through 24 inches](#) is [0.375-inch](#) wall, seamless welded black carbon steel, conforming to [ASTM A53/A53M](#) Type S (seamless) and [ASME B36.10M](#).

Ensure fittings [2 inches and under](#) are [125-psig](#) wsp, cast iron, screwed end, conforming to [ASTM A126](#) Class A and [ASME B16.4](#).

Ensure fittings [2 inches and under](#) are [150-psig](#) wsp banded black malleable iron screwed, conforming to [ASTM A197/A197M](#) and [ASME B16.3](#).

Ensure fittings [1 through 2 inches](#) are [2,000-or 3,000-psi](#) water, oil, or

gas (wog) to match pipe wall, forged carbon steel socket weld, conforming to [ASTM A105/A105M](#) and [ASME B16.11](#).

Ensure fittings [2 inches and under](#) are [125-psig](#) wsp, cast iron, screwed end, conforming to [ASTM A126](#) Class A and [ASME B16.4](#).

Ensure fittings [2-1/2 inches and over](#) are wall thickness to match pipe, long radius butt weld, black carbon steel, conforming to [ASTM A234/A234M](#), Grade WPB and [ASME B16.9](#).

Ensure couplings [2 inches and under](#) are commercial standard weight for Schedule 40 pipe and commercial extra heavy weight for Schedule 80 pipe, black carbon steel where threaded, and [2,000-or 3,000-psi](#) wog forged carbon steel, conforming to [ASTM A105/A105M](#) and [ASME B16.11](#), where welded.

Ensure flanges [2-1/2 inches and over](#) are [150-pound](#), forged carbon-steel welding neck, with raised face or flat face and concentric serrated finish, conforming to [ASTM A105/A105M](#) and [ASME B16.5](#).

Conform grooved pipe couplings and fittings in accordance with paragraph GROOVED PIPE COUPLINGS AND FITTINGS.

2.1.2 Type CPR, Copper

2.1.2.1 Type CPR-A, Copper Above Ground

Ensure tubing [2 inches and under](#) is seamless copper tubing, conforming to [ASTM B88](#), Type L (hard-drawn for all horizontal and all exposed vertical lines, annealed for concealed vertical lines).

Ensure fittings [2 inches and under](#) are [150-psig](#) wsp wrought-copper solder joint fittings conforming to [ASME B16.22](#).

Ensure unions [2 inches and under](#) are [150-psig](#) wsp wrought-copper solder joint, conforming to [ASME B16.22](#).

Provide brazing rod with Classification BCuP-5, conforming to [AWS A5.8/A5.8M](#).

Use solder, alloy Sb-5, conforming to [ASTM B32](#).

2.2 PIPING SPECIALTIES

Submit equipment and performance data for [piping specialties](#) consisting of corrosion resistance, life expectancy, gage tolerances, and grade line analysis. Submit design analysis and calculations consisting of surface resistance, rates of flow, head losses, inlet and outlet design, required radius of bend, and pressure calculations. Also include in data pipe size, shape, and dimensions, as well as temperature ratings, vibration and thrust limitations minimum burst pressures, shut-off and non-shock pressures and weld characteristics.

2.2.1 Air Separator

Air separated from converter discharge water is ejected by a reduced-velocity device vented to the compression tank.

Provide a commercially constructed separator, designed and certified to separate not less than 80 percent of entrained air on the first passage of

water and not less than 80 percent of residual on each successive pass. Provide shop drawings detailing all piping connections proposed for this work.

Ensure the air separator is carbon steel, designed, fabricated, tested, and stamped in conformance with ASME BPVC SEC VIII D1 for service pressures not less than 125 psi.

2.2.2 Air Vents

Provide manual air vents using 3/8-inch globe valves.

Provide automatic air vents on pumps, mains, and where indicated using ball-float construction. Ensure the vent inlet is not less than 3/4-inch ips and the outlet not less than 1/4-inch ips. Orifice size is 1/8 inch. Provide corrosion-resistant steel trim conforming to ASTM A276/A276M. Fit vent with try-cock. Ensure vent discharges air at any pressure up to 150 psi. Ensure outlet is copper tube routed.

2.2.3 Compression Tank

Provide compression tank designed, fabricated, tested, and stamped for a working pressure of not less than 125 psi in accordance with ASME BPVC SEC VIII D1. Ensure tank is hot-dip galvanized after fabrication to produce not less than 1.5 ounces of zinc coating per square foot of single-side surface.

Tank accessories include red-lined gage-glass complete with glass protectors and shutoff valves, air charger and drainer, and manual vent.

2.2.4 Dielectric Connections

Electrically isolate dissimilar pipe metals from each other by couplings, unions, or flanges commercially manufactured for that purpose and rated for the service pressure and temperature.

2.2.5 Expansion Vibration Isolation Joints

Construct single or multiple arch-flanged expansion vibration isolation joints of steel-ring reinforced chloroprene-impregnated cloth materials. Design joint to absorb the movement of the pipe sections in which installed with no detrimental effect on the pipe or connected equipment. Back flanges with ferrous-metal backing rings. Provide control rod assemblies to restrict joint movement. Coat all nonmetallic exterior surfaces of the joint with chlorosulphonated polyethylene. Provide grommets in limit bolt hole to absorb noise transmitted through the bolts.

Ensure joints are suitable for continuous-duty working temperature of at least 250 degrees F.

Fill arches with soft chloroprene.

Ensure joint, single-arch, movement limitations and size-related, pressure characteristics conform to FSA-0017.

2.2.6 Flexible Pipe

Construct flexible pipe vibration and pipe-noise eliminators of wire-reinforced, rubber-impregnated cloth and cord materials and be

flanged. Back the flanges with ferrous-metal backing rings. Ensure service pressure-rating is a minimum 1.5 times actual service, with surge pressure at 180 degrees F.

Construct flexible pipe vibration and pipe noise eliminators of wire-reinforced chloroprene-impregnated cloth and cord materials. Ensure the pipe is flanged. Provide all flanges backed with ferrous-metal backing rings. Coat nonmetallic exterior surfaces of the flexible pipe with an acid- and oxidation-resistant chlorosulphonated polyethylene. Rate the flexible pipe for continuous duty at 130 psi and 250 degrees F.

Ensure unit pipe lengths, face-to-face, are not less than the following:

<u>INSIDE DIAMETER</u>	<u>UNIT PIPE LENGTH</u>
To 2-1/2 inches, inclusive	12 inches
3 to 4 inches, inclusive	18 inches
5 to 12 inches, inclusive	24 inches

2.2.7 Flexible Metallic Pipe

Ensure flexible pipe is the bellows-type with wire braid cover and designed, constructed, and rated in accordance with the applicable requirements of ASME B31.3.

Minimum working pressure rating is 50 psi at 300 degrees F.

Ensure flanged end connection rating and materials conform to specifications for system primary-pressure rating.

2.2.8 Pressure Gages

Ensure pressure gages conform to ASME B40.100 and to requirements specified herein. Pressure-gage size is 3-1/2 inches nominal diameter. Ensure case is corrosion-resistant steel, conforming to any of the AISI 300 series of ASTM A6/A6M, with an ASM No. 4 standard commercial polish or better. Equip gages with adjustable red marking pointer and damper-screw adjustment in inlet connection. Align service-pressure reading at midpoint of gage range. Ensure all gages are Grade B or better and be equipped with gage isolators.

2.2.9 Thermometers

Ensure thermometers conform to ASTM E1, except for being filled with a red organic liquid. Provide an industrial pattern armored glass thermometer, (well-threaded and seal-welded). Ensure thermometers installed 6 feet or higher above the floor have an adjustable angle body. Ensure scale is not less than 7 inches long and the case face is manufactured from manufacturer's standard polished aluminum or AISI 300 series polished corrosion-resistant steel. Thermometer range is 0-200. Provide thermometers with nonferrous separable wells. Provide lagging extension to accommodate insulation thickness.

2.2.10 Pump Suction Strainers

Provide a cast iron strainer body, rated for not less than 25 psig at 100 degrees F, with flanges conforming to ASME B16.1, Class 125. Strainer construction is such that there is a machined surface joint between body and basket that is normal to the centerline of the basket.

Ensure minimum ratio of open area of each basket to pipe area is 3 to 1. Provide a basket with AISI 300 series corrosion-resistant steel wire mesh with perforated backing.

Ensure mesh is capable of retaining all particles larger than 1,000 micrometer, with a pressure drop across the strainer body of not more than 0.5 psi when the basket is two-thirds dirty at maximum system flow rate. Provide reducing fittings from strainer-flange size to pipe size.

Provide a differential-pressure gage fitted with a two-way brass cock across the strainer.

Provide manual air vent cocks in cap of each strainer.

2.2.11 Line Strainers, Water Service

Provide Y-type strainers with removable basket. Ensure strainers in sizes 2-inch ips and smaller have screwed ends; in sizes 2-1/2-inch ips and larger, strainers have flanged ends. Ensure body working-pressure rating exceeds maximum service pressure of installed system by at least 50 percent. Ensure body has cast-in arrows to indicate direction of flow. Ensure all strainer bodies fitted with screwed screen retainers have straight threads and gasketed with nonferrous metal. For strainer bodies 2-1/2-inches and larger, fitted with bolted-on screen retainers, provide offset blowdown holes. Fit all strainers larger than 2-1/2-inches with manufacturer's standard ball-type blowdown valve. Ensure body material is cast bronze conforming to ASTM B62. Where system material is nonferrous, use nonferrous metal for the metal strainer body material.

Ensure minimum free-hole area of strainer element is equal to not less than 3.4 times the internal area of connecting piping. Strainer screens perforation size is not to exceed 0.045-inch. Ensure strainer screens have finished ends fitted to machined screen chamber surfaces to preclude bypass flow. Strainer element material is AISI Type 304 corrosion-resistant steel.

2.3 VALVES

Submit equipment and performance data for valves consisting of corrosion resistance and life expectancy. Submit design analysis and calculations consisting of rates of flow, head losses, inlet and outlet design, and pressure calculations. Also include in data, pipe dimensions, as well as temperature ratings, vibration and thrust limitations, minimum burst pressures, shut-off and non-shock pressures and weld characteristics.

Polypropylene valves will comply with the performance requirements of ASTM F2389. Valves shall conform to ASME B16.34.

2.3.1 Ball and Butterfly Valves

Ensure ball valves conform to MSS SP-72 for flanged valves and MSS SP-110 for screwed-end valves for Figure 1A 1 piece body, and are rated for

service at not less than 175 psig at 200 degrees F. For valve bodies in sizes 2 inches and smaller, use screwed-end connection-type constructed of Class A copper alloy. For valve bodies in sizes 2-1/2 inches and larger, use flanged-end connection type, constructed of Class D material. Balls and stems of valves 2 inches and smaller are manufacturer's standard with hard chrome plating finish. Balls and stems of valves 2-1/2 inches and larger are manufacturer's standard Class C corrosion-resistant steel alloy with hard chrome plating. Balls of valves 6 inches and larger may be Class D with 900 Brinell hard chrome plating. Ensure valves are suitable for flow from either direction and seal equally tight in either direction. Valves with ball seals held in place by spring washers are not acceptable. Ensure all valves have adjustable packing glands. Seats and seals are fabricated from tetrafluoroethylene.

Ensure butterfly valves conform to MSS SP-67 and are the wafer type for mounting between specified flanges. Ensure valves are rated for 150-psig shutoff and nonshock working pressure. Select bodies of cast ferrous metal conforming to ASTM A126, Class B, and to ASME B16.1 for body wall thickness. Seats and seals are fabricated from resilient elastomer designed for field removal and replacement.

2.3.2 Drain, Vent, and Gage Cocks

Provide lever handle drain, vent, and gage cocks, ground key type, with washer and screw, constructed of polished ASTM B62 bronze, and rated 125-psi wsp. Ensure end connections are rated for specified service pressure.

Ensure pump vent cocks, and where spray control is required, are UL umbrella-hood type, constructed of manufacturer's standard polished brass. Ensure cocks are 1/2-inch ips male, end threaded, and rated at not less than 125 psi at 225 degrees F.

2.3.3 Gate Valves (GAV)

Ensure gate valves 2 inches and smaller conform to MSS SP-80. For valves located in tunnels, equipment rooms, factory-assembled equipment, and where indicated use union-ring bonnet, screwed-end type. Make packing of non-asbestos type materials. Use rising stem type valves.

Ensure gate valves 2-1/2 inches and larger, are Type I, (solid wedge disc, tapered seats, steam rated); Class 125 (125-psig steam-working pressure at 353 degrees F saturation); and 200-psig, wog (nonshock), conforming to MSS SP-70 and to requirements specified herein. Select flanged valves, with bronze trim and outside screw and yoke (OS&Y) construction. Make packing of non-asbestos type materials.

2.3.4 Globe and Angle Valves (GLV-ANV)

Ensure globe and angle valves 2 inches and smaller, are 125-pound, 125-psi conforming to MSS SP-80 and to requirements specified herein. For valves located in tunnels, equipment rooms, factory-assembled equipment, and where indicated, use union-ring bonnet, screwed-end type. Ensure disc is free to swivel on the stem in all valve sizes. Composition seating-surface disc construction may be substituted for all metal-disc construction. Make packing of non-asbestos type materials. Ensure disk and packing are suitable for pipe service installed.

Ensure globe and angle valves, 2-1/2 inches and larger, are cast iron with

bronze trim. Ensure valve bodies are cast iron conforming to [ASTM A126](#), Class A, as specified for Class 1 valves under [MSS SP-80](#). Select flanged valves in conformance with [ASME B16.1](#). Valve construction is outside screw and yoke (OS&Y) type. Make packing of non-asbestos type materials.

2.3.5 Standard Check Valves (SCV)

Ensure standard check valves in sizes [2 inches](#) and smaller are [125-psi](#) swing check valves except as otherwise specified. Provide lift checks where indicated. Ensure swing-check pins are nonferrous and suitably hard for the service. Select composition type discs. Ensure the swing-check angle of closure is manufacturer's standard unless a specific angle is needed.

Use cast iron, bronze trim, swing type check valves in sizes [2-1/2 inches](#) and larger. Ensure valve bodies are cast iron, conforming to [ASTM A126](#), Class A and valve ends are flanged in conformance with [ASME B16.1](#). Swing-check pin is AISI Type or approved equal corrosion-resistant steel. Angle of closure is manufacturer's standard unless a specific angle is needed. Ensure valves have bolted and gasketed covers.

Provide check valves with external spring-loaded, positive-closure devices and valve ends are flanged.

2.3.6 Nonslam Check Valves (NSV)

Provide check valves at pump discharges in sizes [2 inches](#) and larger with nonslam or silent-check operation conforming to [MSS SP-125](#). Select a valve disc or plate that closes before line flow can reverse to eliminate slam and water-hammer due to check-valve closure. Ensure valve is Class 125 rated for [200-psi](#) maximum, nonshock pressure at [150 degrees F](#) in sizes to [12 inches](#). Use valves that are wafer type to fit between flanges conforming to [ASME B16.1](#). Valve body may be cast iron, or equivalent strength ductile iron. Select disks using manufacturer's standard bronze, aluminum bronze, or corrosion-resistant steel. Ensure pins, springs, and miscellaneous trim are manufacturer's standard corrosion-resistant steel. Disk and shaft seals are Buna-N elastomer tetrafluoroethylene.

2.4 MISCELLANEOUS MATERIALS

Submit equipment and performance data for [miscellaneous materials](#) consisting of corrosion resistance, life expectancy, gage tolerances, and grade line analysis.

2.4.1 Bituminous Coating

Ensure the bituminous coating is a solvent cutback, heavy-bodied material to produce not less than a [12-mil](#) dry-film thickness in one coat, and is recommended by the manufacturer to be compatible with factory-applied coating and rubber joints.

For previously coal-tar coated and uncoated ferrous surfaces underground, use bituminous coating solvent cutback coal-tar type, conforming to [MIL-C-18480](#).

2.4.2 Bolting

Ensure flange and general purpose bolting is hex-head and conforms to [ASTM A307](#), [Grade B](#) (bolts, for flanged joints in piping systems where one

or both flanges are cast iron). Heavy hex-nuts conform to [ASTM A563](#). Square-head bolts and nuts are not acceptable. Ensure threads are coarse-thread series.

2.4.3 Elastomer Caulk

Use two-component polysulfide- or polyurethane-base elastomer caulking material, conforming to [ASTM C920](#).

2.4.4 Escutcheons

Manufacture escutcheons from nonferrous metals and chrome-plated except when AISI 300 series corrosion-resistant steel is provided. Ensure metals and finish conforms to [ASME A112.19.2/CSA B45.1](#).

Use one-piece escutcheons where mounted on chrome-plated pipe or tubing, and one-piece of split-pattern type elsewhere. Ensure all escutcheons have provisions consisting of setscrews for maintaining a fixed position against a surface.

2.4.5 Flashing

Ensure sheetlead conforms to [ASTM B749](#), UNS Alloy Number L51121 (for use where lead sheet of high purity and improved structural strength is indicated).

Ensure sheet copper conforms to [ASTM B370](#) and be not less than 16 ounces per square foot weight.

2.4.6 Flange Gaskets

Provide compressed non-asbestos sheets, conforming to [ASTM F104](#), coated on both sides with graphite or similar lubricant, with nitrile composition, binder rated to 750 degrees F.

2.4.7 Grout

Provide shrink-resistant grout as a premixed and packaged metallic-aggregate, mortar-grouting compound conforming to [ASTM C404](#) and [ASTM C476](#).

Ensure shrink-resistant grout is a combination of pre-measured and packaged epoxy polyamide or amine resins and selected aggregate mortar grouting compound conforming to the following requirements:

Tensile strength	1,900 psi, minimum
Compressive strength ASTM C109/C109M	14,000 psi, minimum
Shrinkage, linear	0.00012 inch per inch, maximum
Water absorption ASTM C67/C67M	0.1 percent, maximum
Bond strength to	1,000 psi, minimum steel in shear minimum

2.4.8 Pipe Thread Compounds

Use polytetrafluoroethylene tape not less than 2 to 3 mils thick in

potable and process water and in chemical systems for pipe sizes to and including 1-inch ips. Use polytetrafluoroethylene dispersions and other suitable compounds for all other applications upon approval by the Contracting Officer; however, do not use lead-containing compounds in potable water systems.

2.5 SUPPORTING ELEMENTS

Submit equipment and performance data for the supporting elements consisting of corrosion resistance, life expectancy, gage tolerances, and grade line analysis.

Provide all necessary piping systems and equipment supporting elements, including but not limited to: building structure attachments; supplementary steel; hanger rods, stanchions, and fixtures; vertical pipe attachments; horizontal pipe attachments; anchors; guides; and spring-cushion, variable, or constant supports. Ensure supporting elements are suitable for stresses imposed by systems pressures and temperatures and natural and other external forces normal to this facility without damage to supporting element system or to work being supported.

Ensure supporting elements conform to requirements of ASME B31.3, and MSS SP-58, except as noted.

Ensure attachments welded to pipe are made of materials identical to that of pipe or materials accepted as permissible raw materials by referenced code or standard specification.

Ensure supporting elements exposed to weather are hot-dip galvanized or stainless steel. Select materials of such a nature that their apparent and latent-strength characteristics are not reduced due to galvanizing process. Electroplate supporting elements in contact with copper tubing with copper.

Type designations specified herein are based on MSS SP-58. Ensure masonry anchor group-, type-, and style-combination designations are in accordance with CID A-A-1922, CID A-A-1923, CID A-A-1924, CID A-A-1925, CID A-A-55614, and CID A-A-55615. Provide support elements, except for supplementary steel, that are cataloged, load rated, commercially manufactured products.

2.5.1 Building Structure Attachments

2.5.1.1 Anchor Devices, Concrete and Masonry

Ensure anchor devices conform to CID A-A-1922, CID A-A-1923, CID A-A-1924, CID A-A-1925, CID A-A-55614, and CID A-A-55615

For cast-in, floor mounted, equipment anchor devices, provide adjustable positions.

Provide built-in masonry anchor devices.

Do not use powder-actuated anchoring devices to support any mechanical systems components.

2.5.1.2 C-Clamps

Do not use C-clamps.

2.5.1.3 Inserts, Concrete

Use concrete **MSS SP-58** Type 18 inserts. When applied to piping in sizes **2 inches ips** and larger and where otherwise required by imposed loads, insert and wire a **1-foot** length of **1/2-inch** reinforcing rod through wing slots. Submit proprietary-type continuous inserts for approval.

2.5.2 Horizontal Pipe Attachments

2.5.2.1 Single Pipes

Support piping in sizes to and including **2-inch ips** by **MSS SP-58** Type 6 solid malleable iron pipe rings, except that, use split-band-type rings in sizes up to **1-inch ips**.

Support piping in sizes through **8-inch ips** inclusive by **MSS SP-58** Type 1 attachments.

Use **MSS SP-58** Type 1 and Type 6 assemblies on vapor-sealed insulated piping and have an inside diameter larger than pipe being supported to provide adequate clearance during pipe movement.

Where thermal movement of a point in a piping system **4 inches** and larger would cause a hanger rod to deflect more than 4 degrees from the vertical or where a horizontal point movement exceeds **1/2 inch**, use **MSS SP-58** Type 41 pipe rolls.

Support piping in sizes larger than **8-inch ips** with **MSS SP-58** Type 41 pipe rolls.

Use **MSS SP-58** Type 40 shields on all insulated piping. Ensure area of the supporting surface is such that compression deformation of insulated surfaces does not occur. Roll away longitudinal and transverse shield edges from the insulation.

Provide insulated piping without vapor barrier on roll supports with **MSS SP-58** Type 39 saddles.

Provide spring supports as indicated.

2.5.2.2 Parallel Pipes

Use trapeze hangers fabricated from structural steel shapes, with U-bolts, in congested areas and where multiple pipe runs occur. Ensure structural steel shapes **be of commercially available, propriety design, rolled steel.**

2.5.3 Vertical Pipe Attachments

Ensure vertical pipe attachments are **MSS SP-58** Type 8.

Include complete fabrication and attachment details of any spring supports in shop drawings.

2.5.4 Hanger Rods and Fixtures

Use only circular cross section rod hangers to connect building structure attachments to pipe support devices. Use pipe, straps, or bars of equivalent strength for hangers only where approved by the Contracting Officer.

Provide turnbuckles, swing eyes, and clevises as required by support system to accommodate temperature change, pipe accessibility, and adjustment for load and pitch. Rod couplings are not acceptable.

2.5.5 Supplementary Steel

Where it is necessary to frame structural members between existing members or where structural members are used in lieu of commercially rated supports, design and fabricate such supplementary steel in accordance with [AISC 325](#).

PART 3 EXECUTION

3.1 PIPE INSTALLATION

Submit certificates for pipes, valves and specialties showing conformance with test requirements as contained in the reference standards contained in this section. Provide certificates verifying [Surface Resistance](#), [Shear and Tensile Strengths](#), [Temperature Ratings](#), [Bending Tests](#), [Flattening Tests](#) and [Transverse Guided Weld Bend Tests](#).

Provide test reports for [Hydrostatic Tests](#), [Air Tests](#), [Valve-Operating Tests](#), [Drainage Tests](#), [Pneumatic Tests](#), [Non-Destructive Electric Tests](#) and [System Operation Tests](#), in compliance with referenced standards contained within this section.

Fabricate and install piping systems in accordance with [ASME B31.3](#), [MSS SP-58](#), and [AWS WHB-2.9](#).

Submit [Installation Drawings](#) for pipes, valves and specialties. Drawings include the manufacturer's design and construction calculations, forces required to obtain rated axial, lateral, or angular movements, installation criteria, anchor and guide requirements for equipment, and equipment room layout and design. Ensure drawings specifically advise on procedures to be followed and provisions required to protect expansion joints during specified hydrostatic testing operations.

Ensure connections between steel piping and copper piping are electrically isolated from each other. Dielectric pipe unions shall be installed to prevent galvanic corrosion. The dielectric unions shall have metal connections on both ends. The ends shall be threaded, flanged, or brazed to match adjacent piping. The metal parts of the union shall be separated so that the electrical current is below 1 percent of the galvanic current which would exist upon metal-to-metal contact. Gaskets, flanges, and unions shall be installed in accordance with manufacturer's recommendations.

Provide dielectric nipples between steel piping and copper piping to reduce galvanic corrosion. Dielectric nipples shall be Schedule 40 galvanized steel conforming to [ASTM A53/A53M](#) with inert, non-corrosive thermoplastic lining. For pipe sizes [2 inches ips](#) smaller, a bronze ball valve can be used between dissimilar metals.

Make final connections to equipment with flanges installed every [100 feet](#) of straight run. Install unions in the line downstream of screwed- and welded-end valves.

Ream all pipe ends before joint connections are made.

Make screwed joints with specified joint compound with not more than three threads showing after joint is made up.

Apply joint compounds to the male thread only and exercise care to prevent compound from reaching the unthreaded interior of the pipe.

Install screwed unions, welded unions, or bolted flanges wherever required to permit convenient removal of equipment, valves, and piping accessories from the piping system for maintenance.

Securely support piping systems with due allowance for thrust forces, thermal expansion and contraction. Do not subject the system to mechanical, chemical, vibrational or other damage as specified in [ASME B31.3](#).

Ensure field welded joints conform to the requirements of the [AWS WHB-2.9](#), [ASME B31.3](#), and [ASME BPVC SEC IX](#).

Make piping systems butt weld joints with backing rings. Use compatible backing ring materials with materials being joined. Ensure joint configuration conforms to [ASME B16.25](#).

Accomplish preheat and postheat treatment of welds in accordance with [ASME BPVC SEC IX](#) and [ASME B31.3](#).

Take all necessary precautions during installation of flexible pipe and hose including flushing and purging with water, to preclude bellows failure due to pipe line debris lodged in bellows. Ensure installation conforms to manufacturer's instructions.

3.2 VALVES

Install valves in piping mains and all branches and at equipment where indicated and as specified.

Install valves to permit isolation of branch piping and each equipment item from the balance of the system.

Install riser and downcomer drains above piping shutoff valves in piping [2-1/2 inches](#) and larger. Tap and fit shutoff valve body with a [1/2-inch](#) plugged globe valve.

Install valves unavoidably located in furred or other normally inaccessible places with access panels adequately sized for the location and located so that concealed items may be serviced, maintained, or replaced.

3.3 SUPPORTING ELEMENTS INSTALLATION

Install supporting elements in accordance with the referenced codes and standards.

Support piping from building structure. Do not support piping from roof deck or from other pipe.

Run piping parallel with the lines of the building. Space and install piping and components so that a threaded pipe fitting may be removed between adjacent pipes and so that there is no less than [1/2 inch](#) of clear

space between the finished surface and other work and between the finished surface of parallel adjacent piping. Arrange hangars on different adjacent service lines running parallel with each other in line with each other and parallel to the lines of the building.

Install piping support elements at intervals specified hereinafter, at locations not more than **3 feet** from the ends of each runout, and not over **1 foot** from each change in direction of piping.

Base load rating for all pipe-hanger supports on insulated weight of lines filled with water and forces imposed. Deflection per span is not exceed slope gradient of pipe. Ensure supports are in accordance with the following minimum rod size and maximum allowable hanger spacing for specified pipe. For concentrated loads such as valves, reduce the allowable span proportionately:

<u>PIPE SIZE</u> <u>INCHES</u>	<u>ROD SIZE</u> <u>INCHES</u>	<u>STEEL PIPE</u> <u>FEET</u>	<u>COPPER PIPE</u> <u>FEET</u>
1 and smaller	3/8	8	6
1-1/4 to 1-1/2	3/8	10	8
2	3/8	10	8
2-1/2 to 3-1/2	1/2	12	12
4 to 5	5/8	16	14

Install vibration isolation supports where needed.

Support vertical risers independently of connected horizontal piping, whenever practicable, with fixed or spring supports at the base and at intervals to accommodate system range of thermal conditions. Ensure risers have guides for lateral stability. For risers subject to expansion, install only one rigid support at a point approximately one-third down from the top. Place clamps under fittings unless otherwise specified. Support carbon-steel pipe at each floor and at not more than **15-foot** intervals for pipe **2 inches** and smaller and at not more than **20-foot** intervals for pipe **2-1/2 inches** and larger.

3.4 PENETRATIONS

Accomplish sound stopping and vapor-barrier sealing of pipe shafts and large floor and wall openings by packing to high density with properly supported fibrous-glass insulation or, where ambient or surface temperatures do not exceed **120 degrees F**, by foaming-in-place with self-extinguishing, **2-pound** density polyurethane foam to a depth not less than **6 inches**. Finish foam with a rasp. Ensure vapor barrier is not less than **1/8-inch** thick vinyl coating applied to visible and accessible surfaces. Where high temperatures and fire stopping are a consideration, use only mineral wool with openings covered by **16-gage** sheet metal.

3.5 SLEEVES

Install sleeves where piping passes through roofs, masonry, concrete walls and floors.

Ensure sleeves that extend through floors, roofs, load bearing walls, and fire barriers are continuous and fabricated from Schedule 40 steel pipe, with welded anchor lugs. Form all other sleeves by molded linear polyethylene liners or similar materials that are removable. Ensure diameter of sleeves is large enough to accommodate pipe, insulation, and jacketing without touching the sleeve and provides a minimum **3/8-inch** clearance. Install a sleeve size to accommodate mechanical and thermal motion of pipe precluding transmission of vibration to walls and the generation of noise.

Pack the space between a pipe, bare or insulated, and the inside of a pipe sleeve or a construction surface penetration solid with a mineral fiber conforming to **ASTM C553** Type V (flexible blanket), **to 1,000 degrees F**. Install this packing wherever the piping passes through firewalls, equipment room walls, floors, and ceilings connected to occupied spaces, and other locations where sleeves or construction-surface penetrations occur between occupied spaces. Where sleeves or construction surface penetrations occur between conditioned and unconditioned spaces, fill the space between a pipe, bare or insulated, and the inside of a pipe sleeve or construction surface penetration with an elastomer caulk to a depth of **1/2 inch**. Ensure all caulked surfaces are oil- and grease-free.

Ensure through-penetration fire stop materials and methods are in accordance with **ASTM E814** and **UL 1479**.

Caulk exterior wall sleeves watertight with lead and oakum or mechanically expandable chloroprene inserts with mastic-sealed metal components.

3.6 ESCUTCHEONS

Install escutcheons at all penetrations of piping into finished areas. Where finished areas are separated by partitions through which piping passes, install escutcheons on both sides of the partition. Where suspended ceilings are installed, install plates at the underside only of such ceilings. For insulated pipes, select plates large enough to fit around the insulation. Use chrome-plated escutcheons in all occupied spaces and of size sufficient to effectively conceal openings in building construction. Firmly attach escutcheons with setscrews.

3.7 FLASHINGS

Install flashings at penetrations of building boundaries by mechanical systems and related work.

3.8 DISINFECTION

Flush piping with potable water until visible grease, dirt and other contaminants are removed (visual inspection).

3.9 OPERATION AND MAINTENANCE

Provide **Operation and Maintenance Manuals** consistent with manufacturer's standard brochures, schematics, printed instructions, general operating procedures and safety precautions. Submit test data that is clear and

readily legible.

3.10 PAINTING OF NEW EQUIPMENT

Factory or shop apply new equipment painting, as specified herein, and provided under each individual section.

3.10.1 Factory Painting Systems

Manufacturer's standard factory painting systems may be provided subject to certification that the factory painting system applied withstands 125 hours in a salt-spray fog test, except that equipment located outdoors withstand 500 hours in a salt-spray fog test. Conduct salt-spray fog test is in accordance with [ASTM B117](#), and for that test the acceptance criteria is as follows: immediately after completion of the test, the inspected paint shows no signs of blistering, wrinkling, or cracking, and no loss of adhesion; and the specimen shows no signs of rust creepage beyond [0.125 inch](#) on either side of the scratch mark.

Ensure the film thickness of the factory painting system applied on the equipment is not less than the film thickness used on the test specimen. If manufacturer's standard factory painting system is being proposed for use on surfaces subject to temperatures above [120 degrees F](#), design the factory painting system for the temperature service.

3.10.2 Shop Painting Systems for Metal Surfaces

Clean, pretreat, prime and paint metal surfaces; except aluminum surfaces need not be painted. Apply coatings to clean dry surfaces. Clean the surfaces to remove dust, dirt, rust, oil and grease by wire brushing and solvent degreasing prior to application of paint, except clean to bare metal, surfaces subject to temperatures in excess of [120 degrees F](#).

Where more than one coat of paint is specified, apply the second coat after the preceding coat is thoroughly dry. Lightly sand damaged painting and retouch before applying the succeeding coat. Selected color of finish coat is aluminum or light gray.

- a. Temperatures Less Than [120 Degrees F](#): Immediately after cleaning, the metal surfaces subject to temperatures less than [120 degrees F](#) receives one coat of pretreatment primer applied to a minimum dry film thickness of [0.3 mil](#), one coat of primer applied to a minimum dry film thickness of [one mil](#); and two coats of enamel applied to a minimum dry film thickness of [one mil](#) per coat.
- b. Temperatures Between [120 and 400 Degrees F](#): Metal surfaces subject to temperatures between [120 and 400 degrees F](#) Receives two coats of [400 degrees F](#) heat-resisting enamel applied to a total minimum thickness of [2 mils](#).
- c. Temperatures Greater Than [400 Degrees F](#): Metal surfaces subject to temperatures greater than [400 degrees F](#) receives two coats of [600 degrees F](#) heat-resisting paint applied to a total minimum dry film thickness of [2 mils](#).

-- End of Section --

SECTION 23 05 93

TESTING, ADJUSTING, AND BALANCING FOR HVAC
11/15

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ACOUSTICAL SOCIETY OF AMERICA (ASA)

ASA S1.4 (1983; Amendment 1985; R 2006)
Specification for Sound Level Meters (ASA 47)

ASA S1.11 PART 1 (2014) American National Standard
Electroacoustics - Octave-Band and
Fractional-Octave-Band Filters - Part 1:
Specifications

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING
ENGINEERS (ASHRAE)

ASHRAE 62.1 (2016) Ventilation for Acceptable Indoor
Air Quality

ASHRAE HVAC APP IP HDBK (2016) HVAC Applications Handbook, I-P
Edition

ASSOCIATED AIR BALANCE COUNCIL (AABC)

AABC MN-1 (2002; 6th ed) National Standards for
Total System Balance

NATIONAL ENVIRONMENTAL BALANCING BUREAU (NEBB)

NEBB MASV (2006) Procedural Standards for
Measurements and Assessment of Sound and
Vibration

NEBB PROCEDURAL STANDARDS (2015) Procedural Standards for TAB
(Testing, Adjusting and Balancing)
Environmental Systems

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION
(SMACNA)

SMACNA 1780 (2002) HVAC Systems - Testing, Adjusting
and Balancing, 3rd Edition

SMACNA 1858 (2004) HVAC Sound And Vibration Manual -
First Edition

SMACNA 1972 CD (2012) HVAC Air Duct Leakage Test Manual -

2nd Edition

1.2 DEFINITIONS

- a. AABC: Associated Air Balance Council
- b. COTR: Contracting Officer's Technical Representative
- c. DALT: Duct air leakage test
- d. DALT'd: Duct air leakage tested
- e. HVAC: Heating, ventilating, and air conditioning; or heating, ventilating, and cooling
- f. NEBB: National Environmental Balancing Bureau
- g. Out-of-tolerance data: Pertains only to field acceptance testing of Final DALT or TAB report. When applied to DALT work, this phrase means "a measurement taken during TAB field acceptance testing which does not fall within the range of plus 5 to minus 5 percent of the original measurement reported on the TAB Report for a specific parameter."
- h. Season of maximum heating load: The time of year when the outdoor temperature at the project site remains within **plus or minus 30 degrees Fahrenheit** of the project site's winter outdoor design temperature, throughout the period of TAB data recording.
- i. Season of maximum cooling load: The time of year when the outdoor temperature at the project site remains within **plus or minus 5 degrees Fahrenheit** of the project site's summer outdoor design temperature, throughout the period of TAB data recording.
- j. Season 1, Season 2: Depending upon when the project HVAC is completed and ready for TAB, Season 1 is defined, thereby defining Season 2. Season 1 could be the season of maximum heating load, or the season of maximum cooling load.
- k. Sound measurements terminology: Defined in **AABC MN-1**, **NEBB MASV**, or **SMACNA 1858** (TABB).
- l. TAB: Testing, adjusting, and balancing (of HVAC systems)
- m. TAB'd: HVAC Testing/Adjusting/Balancing procedures performed
- n. TAB Agency: TAB Firm
- o. TABB: Testing Adjusting and Balancing Bureau

1.2.1 Similar Terms

In some instances, terminology differs between the Contract and the TAB Standard primarily because the intent of this Section is to use the industry standards specified, along with additional requirements listed herein to produce optimal results.

The following table of similar terms is provided for clarification only. Contract requirements take precedent over the corresponding AABC, NEBB, or

TABB requirements where differences exist.

SIMILAR TERMS			
Contract Term	AABC Term	NEBB Term	TABB Term
TAB Standard	National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems	Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems	International Standards for Environmental Systems Balance
TAB Specialist	TAB Engineer	TAB Supervisor	TAB Supervisor
Systems Readiness Check	Construction Phase Inspection	Field Readiness Check & Preliminary Field Procedures	Field Readiness Check & Prelim. Field Procedures

1.3 WORK DESCRIPTION

The work includes duct air leakage testing (DALT) and testing, adjusting, and balancing (TAB) of new heating, ventilating, and cooling (HVAC) air and water distribution systems including equipment and performance data, ducts, and piping which are located within, on, under, between, and adjacent to buildings.

Perform TAB in accordance with the requirements of the TAB procedural standard recommended by the TAB trade association that approved the TAB Firm's qualifications. Comply with requirements of AABC MN-1, NEBB PROCEDURAL STANDARDS, or SMACNA 1780 (TABB) as supplemented and modified by this specification section. All recommendations and suggested practices contained in the TAB procedural standards are considered mandatory.

Conduct DALT and TAB of the indicated existing systems and equipment and submit the specified DALT and TAB reports for approval. Conduct DALT testing in compliance with the requirements specified in SMACNA 1972 CD, except as supplemented and modified by this section. Conduct DALT and TAB work in accordance with the requirements of this section.

1.3.1 Air Distribution Systems

Test, adjust, and balance systems (TAB) in compliance with this section. Obtain Contracting Officer's written approval before applying insulation to exterior of air distribution systems as specified under Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

1.3.2 Water Distribution Systems

TAB systems in compliance with this section. Obtain Contracting Officer's written approval before applying insulation to water distribution systems as specified under Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS. At Contractor's option and with Contracting Officer's written approval, the piping systems may be insulated before systems are TAB'd.

Terminate piping insulation immediately adjacent to each flow control valve, automatic control valve, or device. Seal the ends of pipe insulation and the space between ends of pipe insulation and piping, with waterproof vapor barrier coating.

After completion of work under this section, insulate the flow control valves and devices as specified under Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

1.3.3 TAB SCHEMATIC DRAWINGS

Show the following information on TAB Schematic Drawings:

1. A unique number or mark for each piece of equipment or terminal.
2. Air quantities at air terminals.
3. Air quantities and temperatures in air handling unit schedules.
4. Water quantities and temperatures in thermal energy transfer equipment schedules.
5. Water quantities and heads in pump schedules.
6. Water flow measurement fittings and balancing fittings.
7. Ductwork Construction and Leakage Testing Table that defines the DALT test requirements, including each applicable HVAC duct system ID or mark, duct pressure class, duct seal class, and duct leakage test pressure. This table is included in the file for Graphics for Unified Facilities Guide Specifications:

<http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms-gra>

Submit three copies of the [TAB Schematic Drawings and Report Forms](#) to the Contracting Officer, no later than 21 days prior to the start of TAB field measurements.

1.4 SUBMITTALS

Government approval is required for submittals. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

[SD-02 Shop Drawings](#)

[TAB Schematic Drawings and Report Forms](#)

[SD-03 Product Data](#)

[Equipment and Performance Data](#)

[TAB Related HVAC Submittals](#)

A list of the TAB Related HVAC Submittals, no later than 7 days after the approval of the TAB team engineer and assistant.

[SD-06 Test Reports](#)

[Certified Final DALT Report](#)

Certified Tab Reports

SD-07 Certificates

Independent TAB Agency and Personnel Qualifications

DALT and TAB Submittal and Work Schedule

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: Within 30 days of Contractor's Notice to Proceed, submit documentation that the TAB specialist and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.
- B. Contract Documents Examination Report: Within 30 days of Contractor's Notice to Proceed, submit the Contract Documents review report as specified in Part 3.
- C. Strategies and Procedures Plan: Within 30 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.
- D. System Readiness Checklists: Within 30 days of Contractor's Notice to Proceed, submit system readiness checklists as specified in "Preparation" Article.
- E. Examination Report: Submit a summary report of the examination review required in "Examination" Article.
- F. Certified TAB reports.
- G. Sample report forms.
- H. Instrument calibration reports, to include the following:
 - 1. Instrument type and make.
 - 2. Serial number.
 - 3. Application.
 - 4. Dates of use.
 - 5. Dates of calibration.

1.6 QUALITY ASSURANCE

1.6.1 Independent TAB Agency and Personnel Qualifications

To secure approval for the proposed agency, submit information certifying that the TAB agency is a first tier subcontractor who is not affiliated with any other company participating in work on this contract, including design, furnishing equipment, or construction. Further, submit the following, for the agency, to Contracting Officer for approval:

- a. Independent AABC or NEBB or TABB TAB agency:

TAB agency: AABC registration number and expiration date of

current certification; or NEBB certification number and expiration date of current certification; or TABB certification number and expiration date of current certification.

TAB team supervisor: Name and copy of AABC or NEBB or TABB TAB supervisor certificate and expiration date of current certification.

TAB team field leader: Name and documented evidence that the team field leader has satisfactorily performed full-time supervision of TAB work in the field for not less than 3 years immediately preceding this contract's bid opening date.

TAB team field technicians: Names and documented evidence that each field technician has satisfactorily assisted a TAB team field leader in performance of TAB work in the field for not less than one year immediately preceding this contract's bid opening date.

Current certificates: Registrations and certifications are current, and valid for the duration of this contract. Renew Certifications which expire prior to completion of the TAB work, in a timely manner so that there is no lapse in registration or certification. TAB agency or TAB team personnel without a current registration or current certification are not to perform TAB work on this contract.

- b. TAB Team Members: TAB team approved to accomplish work on this contract are full-time employees of the TAB agency. No other personnel is allowed to do TAB work on this contract.
- c. Replacement of TAB team members: Replacement of members may occur if each new member complies with the applicable personnel qualifications and each is approved by the Contracting Officer.
- d. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."
- e. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."
- f. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.7.2.3 - "System Balancing."

1.7 FIELD CONDITIONS

Full Occupancy: Existing building will be occupied during entire TAB period. Cooperate with Contracting Officer and tenant organization during TAB operations to minimize conflicts with facility's operations.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.1 WORK DESCRIPTIONS OF PARTICIPANTS

Comply with requirements of this section.

3.2 PRE-DALT/TAB MEETING

Meet with the Contracting Officer's technical representative (COTR) and the designing engineer of the HVAC systems to develop a mutual understanding relative to the details of the DALT work and TAB work requirements. Ensure that the TAB supervisor is present at this meeting. Requirements to be discussed include required submittals, work schedule, and field quality control.

Provide a minimum of 14 days' advance notice of scheduled meeting time and location.

1. Minimum Agenda Items:

- a. The Contract Documents examination report.
- b. The TAB plan.
- c. Needs for coordination and cooperation of trades and subcontractors.
- d. Proposed procedures for documentation and communication flow.

3.3 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems designs that may preclude proper TAB of systems and equipment.
- B. Examine installed systems for balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are applicable for intended purpose and are accessible.
- C. TAB Related HVAC Submittals: Examine the approved submittals for HVAC systems and equipment.
- D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems output, and statements of philosophies and assumptions about HVAC system and equipment controls.
- E. Examine ceiling plenums and underfloor air plenums used for supply, return, or relief air to verify that they are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.
- F. Examine equipment performance data including fan and pump curves.
 - 1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
 - 2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201,

"Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design."
Compare results with the design data and installed conditions.

- G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.
- H. Examine test reports specified in individual system and equipment Sections.
- I. Examine HVAC equipment and verify that bearings are greased, belts are aligned and tight, filters are clean, and equipment with functioning controls is ready for operation.
- J. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.
- K. Examine strainers. Verify that startup screens have been replaced by permanent screens with indicated perforations.
- L. Examine control valves for proper installation for their intended function of throttling, diverting, or mixing fluid flows.
- M. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- N. Examine system pumps to ensure absence of entrained air in the suction piping.
- O. Examine operating safety interlocks and controls on HVAC equipment.
- P. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.4 PREPARATION

- A. Prepare a DALT and TAB Submittal and Work Schedule that includes the following:
 - 1. Equipment and systems to be tested.
 - 2. Strategies and step-by-step procedures for balancing the systems.
 - 3. Instrumentation to be used.
 - 4. Sample forms with specific identification for all equipment.
- B. Perform system-readiness checks of HVAC systems and equipment to verify system readiness for TAB work. Include, at a minimum, the following:
 - 1. Airside:
 - a. Verify that leakage and pressure tests on air distribution systems have been satisfactorily completed.

- b. Duct systems are complete with terminals installed.
- c. Volume, smoke, and fire dampers are open and functional.
- d. Clean filters are installed.
- e. Fans are operating, free of vibration, and rotating in correct direction.
- f. Variable-frequency controllers' startup is complete and safeties are verified.
- g. Automatic temperature-control systems are operational.
- h. Ceilings are installed.
- i. Windows and doors are installed.
- j. Suitable access to balancing devices and equipment is provided.

2. Hydronics:

- a. Verify leakage and pressure tests on water distribution systems have been satisfactorily completed.
- b. Piping is complete with terminals installed.
- c. Water treatment is complete.
- d. Systems are flushed, filled, and air purged.
- e. Strainers are pulled and cleaned.
- f. Control valves are functioning per the sequence of operation.
- g. Shutoff and balance valves have been verified to be 100 percent open.
- h. Pumps are started and proper rotation is verified.
- i. Pump gage connections are installed directly at pump inlet and outlet flanges or in discharge and suction pipe prior to valves or strainers.
- j. Variable-frequency controllers' startup is complete and safeties are verified.
- k. Suitable access to balancing devices and equipment is provided.

3.5 GENERAL PROCEDURES FOR TESTING AND BALANCING

Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance" ASHRAE 111 NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" SMACNA's "HVAC Systems - Testing, Adjusting, and Balancing" and in this Section.

- A. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.
 - 1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
 - 2. After testing and balancing, install test ports and duct access doors that comply with requirements in Section 15820 "Air Duct Accessories."
 - 3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Section 22 07 00
- B. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.
- C. Take and report testing and balancing measurements in inch-pound (IP) units.

3.6 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Cross-check the summation of required outlet volumes with required fan volumes.
- B. Prepare schematic diagrams of systems' "as-built" duct layouts.
- C. For variable-air-volume systems, develop a plan to simulate diversity.
- D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.
- E. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.
- F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- G. Verify that motor starters are equipped with properly sized thermal protection.
- H. Check dampers for proper position to achieve desired airflow path.
- I. Check for airflow blockages.
- J. Check condensate drains for proper connections and functioning.
- K. Check for proper sealing of air-handling-unit components.
- L. Verify that air duct system is sealed as specified in Section 23 31 13.00 40.

3.7 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

- A. Adjust fans to deliver total indicated airflows within the maximum

allowable fan speed listed by fan manufacturer.

1. Measure total airflow.
 - a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
 - b. Where duct conditions allow, measure airflow by Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses to obtain total airflow.
 - c. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
 - d. If a reliable Pitot-tube traverse or coil traverse is not possible, measure airflow at terminals and calculate the total airflow.
 2. Measure fan static pressures as follows:
 - a. Measure static pressure directly at the fan outlet or through the flexible connection.
 - b. Measure static pressure directly at the fan inlet or through the flexible connection.
 - c. Measure static pressure across each component that makes up the air-handling system.
 - d. Report artificial loading of filters at the time static pressures are measured.
 3. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
 4. Obtain approval from Owner for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
 5. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload occurs. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.
- B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows.
1. Measure airflow of submain and branch ducts.
 2. Adjust submain and branch duct volume dampers for specified airflow.
 3. Re-measure each submain and branch duct after all have been adjusted.
- C. Adjust air inlets and outlets for each space to indicated airflows.

1. Set airflow patterns of adjustable outlets for proper distribution without drafts.
2. Measure inlets and outlets airflow.
3. Adjust each inlet and outlet for specified airflow.
4. Re-measure each inlet and outlet after they have been adjusted.
- D. Verify final system conditions.
 1. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to design if necessary.
 2. Re-measure and confirm that total airflow is within design.
 3. Re-measure all final fan operating data, rpms, volts, amps, and static profile.
 4. Mark all final settings.
 5. Test system in economizer mode. Verify proper operation and adjust if necessary.
 6. Measure and record all operating data.
 7. Record final fan-performance data.

3.8 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

Adjust the variable-air-volume systems as follows:

1. Verify that the system static pressure sensor is located two-thirds of the distance down the duct from the fan discharge.
2. Verify that the system is under static pressure control.
3. Select the terminal unit that is most critical to the supply-fan airflow. Measure inlet static pressure, and adjust system static pressure control set point so the entering static pressure for the critical terminal unit is not less than the sum of the terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
4. Calibrate and balance each terminal unit for maximum and minimum design airflow as follows:
 - a. Adjust controls so that terminal is calling for maximum airflow. Some controllers require starting with minimum airflow. Verify calibration procedure for specific project.
 - b. Measure airflow and adjust calibration factor as required for design maximum airflow. Record calibration factor.
 - c. When maximum airflow is correct, balance the air outlets downstream from terminal units.

- d. Adjust controls so that terminal is calling for minimum airflow.
 - e. Measure airflow and adjust calibration factor as required for design minimum airflow. Record calibration factor. If no minimum calibration is available, note any deviation from design airflow.
 - f. When in full cooling or full heating, ensure that there is no mixing of hot-deck and cold-deck airstreams unless so designed.
 - g. On constant volume terminals, in critical areas where room pressure is to be maintained, verify that the airflow remains constant over the full range of full cooling to full heating. Note any deviation from design airflow or room pressure.
5. After terminals have been calibrated and balanced, test and adjust system for total airflow. Adjust fans to deliver total design airflows within the maximum allowable fan speed listed by fan manufacturer.
- a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
 - b. Set terminals for maximum airflow. If system design includes diversity, adjust terminals for maximum and minimum airflow so that connected total matches fan selection and simulates actual load in the building.
 - c. Where duct conditions allow, measure airflow by Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses to obtain total airflow.
 - d. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
 - e. If a reliable Pitot-tube traverse or coil traverse is not possible, measure airflow at terminals and calculate the total airflow.
6. Measure fan static pressures as follows:
- a. Measure static pressure directly at the fan outlet or through the flexible connection.
 - b. Measure static pressure directly at the fan inlet or through the flexible connection.
 - c. Measure static pressure across each component that makes up the air-handling system.
 - d. Report any artificial loading of filters at the time static pressures are measured.
7. Set final return and outside airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.
- a. Balance the return-air ducts and inlets the same as described for constant-volume air systems.
 - b. Verify that terminal units are meeting design airflow under system maximum flow.

8. Re-measure the inlet static pressure at the most critical terminal unit and adjust the system static pressure set point to the most energy-efficient set point to maintain the optimum system static pressure. Record set point and give to controls contractor.
9. Verify final system conditions as follows:
 - a. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to match design if necessary.
 - b. Re-measure and confirm that total airflow is within design.
 - c. Re-measure final fan operating data, rpms, volts, amps, and static profile.
 - d. Mark final settings.
 - e. Test system in economizer mode. Verify proper operation and adjust if necessary. Measure and record all operating data.
 - f. Verify tracking between supply and return fans.

3.9 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

- A. Prepare test reports for pumps, coils, and heat exchangers. Obtain approved submittals and manufacturer-recommended testing procedures. Crosscheck the summation of required coil and heat exchanger flow rates with pump design flow rate.
- B. Prepare schematic diagrams of systems' "as-built" piping layouts.
- C. In addition to requirements in "Preparation" Article, prepare hydronic systems for testing and balancing as follows:
 1. Check liquid level in expansion tank.
 2. Check highest vent for adequate pressure.
 3. Check flow-control valves for proper position.
 4. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
 5. Verify that motor starters are equipped with properly sized thermal protection.
 6. Check that air has been purged from the system.

3.10 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

Balance systems with automatic two- and three-way control valves by setting systems at maximum flow through heat-exchange terminals, and proceed as specified above for hydronic systems.

- A. Adjust the variable-flow hydronic system as follows:
 1. Verify that the differential-pressure sensor is located as indicated.

2. Determine whether there is diversity in the system.
- B. For systems with no diversity:
 1. Adjust pumps to deliver total design gpm.
 - a. Measure total water flow.
 - 1) Position valves for full flow through coils.
 - 2) Measure flow by main flow meter, if installed.
 - 3) If main flow meter is not installed, determine flow by pump TDH or exchanger pressure drop.
 - b. Measure pump TDH as follows:
 - 1) Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
 - 2) Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
 - 3) Convert pressure to head and correct for differences in gage heights.
 - 4) Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
 - 5) With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved.
 - c. Monitor motor performance during procedures and do not operate motor in an overloaded condition.
 2. Adjust flow-measuring devices installed in mains and branches to design water flows.
 - a. Measure flow in main and branch pipes.
 - b. Adjust main and branch balance valves for design flow.
 - c. Re-measure each main and branch after all have been adjusted.
 3. Adjust flow-measuring devices installed at terminals for each space to design water flows.
 - a. Measure flow at terminals.
 - b. Adjust each terminal to design flow.
 - c. Re-measure each terminal after it is adjusted.
 - d. Position control valves to bypass the coil and adjust the bypass valve to maintain design flow.
 - e. Perform temperature tests after flows have been balanced.

4. For systems with pressure-independent valves at terminals:
 - a. Measure differential pressure and verify that it is within manufacturer's specified range.
 - b. Perform temperature tests after flows have been verified.
5. For systems without pressure-independent valves or flow-measuring devices at terminals:
 - a. Measure and balance coils by either coil pressure drop or temperature method.
 - b. If balanced by coil pressure drop, perform temperature tests after flows have been verified.
6. Prior to verifying final system conditions, determine the system differential-pressure set point.
7. If the pump discharge valve was used to set total system flow with variable-frequency controller at 60 Hz, at completion open discharge valve 100 percent and allow variable-frequency controller to control system differential-pressure set point. Record pump data under both conditions.
8. Mark final settings and verify that all memory stops have been set.
9. Verify final system conditions as follows:
 - a. Re-measure and confirm that total water flow is within design.
 - b. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
 - c. Mark final settings.
10. Verify that memory stops have been set.
- C. For systems with diversity:
 1. Determine diversity factor.
 2. Simulate system diversity by closing required number of control valves, as approved by the design engineer.
 3. Adjust pumps to deliver total design gpm.
 - a. Measure total water flow.
 - 1) Position valves for full flow through coils.
 - 2) Measure flow by main flow meter, if installed.
 - 3) If main flow meter is not installed, determine flow by pump TDH or exchanger pressure drop.
 - b. Measure pump TDH as follows:

- 1) Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
 - 2) Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
 - 3) Convert pressure to head and correct for differences in gage heights.
 - 4) Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
 - 5) With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved.
- c. Monitor motor performance during procedures and do not operate motor in an overloaded condition.
4. Adjust flow-measuring devices installed in mains and branches to design water flows.
 - a. Measure flow in main and branch pipes.'
 - b. Adjust main and branch balance valves for design flow.
 - c. Re-measure each main and branch after all have been adjusted.
5. Adjust flow-measuring devices installed at terminals for each space to design water flows.
 - a. Measure flow at terminals.
 - b. Adjust each terminal to design flow.
 - c. Re-measure each terminal after it is adjusted.
 - d. Position control valves to bypass the coil, and adjust the bypass valve to maintain design flow.
 - e. Perform temperature tests after flows have been balanced.
6. For systems with pressure-independent valves at terminals:
 - a. Measure differential pressure, and verify that it is within manufacturer's specified range.
 - b. Perform temperature tests after flows have been verified.
7. For systems without pressure-independent valves or flow-measuring devices at terminals:
 - a. Measure and balance coils by either coil pressure drop or temperature method.
 - b. If balanced by coil pressure drop, perform temperature tests after flows have been verified.

8. Open control valves that were shut. Close a sufficient number of control valves that were previously open to maintain diversity, and balance terminals that were just opened.
9. Prior to verifying final system conditions, determine system differential-pressure set point.
10. If the pump discharge valve was used to set total system flow with variable-frequency controller at 60 Hz, at completion open discharge valve 100 percent and allow variable-frequency controller to control system differential-pressure set point. Record pump data under both conditions.
11. Mark final settings and verify that memory stops have been set.
12. Verify final system conditions as follows:
 - a. Re-measure and confirm that total water flow is within design.
 - b. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
 - c. Mark final settings.
13. Verify that memory stops have been set.

3.11 PROCEDURES FOR MOTORS

- A. Motors 1/2 HP and Larger: Test at final balanced conditions and record the following data:
 1. Manufacturer's name, model number, and serial number.
 2. Motor horsepower rating.
 3. Motor rpm.
 4. Phase and hertz.
 5. Nameplate and measured voltage, each phase.
 6. Nameplate and measured amperage, each phase.
 7. Starter size and thermal-protection-element rating.
 8. Service factor and frame size.
- B. Motors Driven by Variable-Frequency Controllers: Test manual bypass of controller to prove proper operation.

3.12 DUCT LEAKAGE TESTS

Witness the duct pressure testing performed by Installer. Verify that proper test methods are used and that leakage rates are within specified tolerances. Report deficiencies observed in the Certified Final DALT Report.

3.13 CONTROLS VERIFICATION

In conjunction with system balancing, perform the following:

1. Verify temperature control system is operating within the design limitations.
2. Confirm that the sequences of operation are in compliance with Contract Documents.
3. Verify that controllers are calibrated and function as intended.
4. Verify that controller set points are as indicated.
5. Verify the operation of lockout or interlock systems.
6. Verify the operation of valve and damper actuators.
7. Verify that controlled devices are properly installed and connected to correct controller.
8. Verify that controlled devices travel freely and are in position indicated by controller: open, closed, or modulating.
9. Verify location and installation of sensors to ensure that they sense only intended temperature, humidity, or pressure.

Reporting: Include a summary of verifications performed, remaining deficiencies, and variations from indicated conditions.

3.14 TOLERANCES

Set HVAC system's airflow rates and water flow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent.
2. Air Outlets and Inlets: Plus or minus 10 percent.
3. Heating-Water Flow Rate: Plus or minus 10 percent.
4. Cooling-Water Flow Rate: Plus or minus 10 percent.

Maintaining pressure relationships as designed shall have priority over the tolerances specified above.

3.15 PROGRESS REPORTING

Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems balancing devices. Recommend changes and additions to systems balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.

Status Reports: Prepare biweekly progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a

list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.16 FINAL REPORT

General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer. Include a list of instruments used for procedures, along with proof of calibration. Certify validity and accuracy of field data.

Final Report Contents: In addition to certified field-report data, include the following:

1. Pump curves.
2. Fan curves.
3. Manufacturers' test data.
4. Field test reports prepared by system and equipment installers.
5. Other information relative to equipment performance; do not include Shop Drawings and Product Data.

General Report Data: In addition to form titles and entries, include the following data:

1. Title page.
2. Name and address of the TAB specialist.
3. Project name.
4. Project location.
5. Architect's name and address.
6. Engineer's name and address.
7. Contractor's name and address.
8. Report date.
9. Signature of TAB supervisor who certifies the report.
10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
11. Summary of contents including the following:
 - a. Indicated versus final performance.
 - b. Notable characteristics of systems.
 - c. Description of system operation sequence if it varies from the Contract Documents.

12. Nomenclature sheets for each item of equipment.
13. Data for terminal units, including manufacturer's name, type, size, and fittings.
14. Notes to explain why certain final data in the body of reports vary from indicated values.
15. Test conditions for fans and pump performance forms including the following:
 - a. Settings for outdoor-, return-, and exhaust-air dampers.
 - b. Conditions of filters.
 - c. Cooling coil, wet- and dry-bulb conditions.
 - d. Face and bypass damper settings at coils.
 - e. Fan drive settings including settings and percentage of maximum pitch diameter.
 - f. Inlet vane settings for variable-air-volume systems.
 - g. Settings for supply-air, static-pressure controller.
 - h. Other system operating conditions that affect performance.
- D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
 1. Quantities of outdoor, supply, return, and exhaust airflows.
 2. Water and steam flow rates.
 3. Duct, outlet, and inlet sizes.
 4. Pipe and valve sizes and locations.
 5. Terminal units.
 6. Balancing stations.
 7. Position of balancing devices.
- E. Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:
 1. Unit Data:
 - a. Unit identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and unit size.

- e. Manufacturer's serial number.
 - f. Unit arrangement and class.
 - g. Discharge arrangement.
 - h. Sheave make, size in inches, and bore.
 - i. Center-to-center dimensions of sheave and amount of adjustments in inches.
 - j. Number, make, and size of belts.
 - k. Number, type, and size of filters.
2. Motor Data:
- a. Motor make, and frame type and size.
 - b. Horsepower and rpm.
 - c. Volts, phase, and hertz.
 - d. Full-load amperage and service factor.
 - e. Sheave make, size in inches, and bore.
 - f. Center-to-center dimensions of sheave and amount of adjustments in inches.
3. Test Data (Indicated and Actual Values):
- a. Total airflow rate in cfm.
 - b. Total system static pressure in inches wg.
 - c. Fan rpm.
 - d. Discharge static pressure in inches wg.
 - e. Filter static-pressure differential in inches wg.
 - f. Preheat-coil static-pressure differential in inches wg.
 - g. Cooling-coil static-pressure differential in inches wg.
 - h. Heating-coil static-pressure differential in inches wg.
 - i. Outdoor airflow in cfm.
 - j. Return airflow in cfm.
 - k. Outdoor-air damper position.
 - l. Return-air damper position.
 - m. Vortex damper position.

F. Apparatus-Coil Test Reports:

1. Coil Data:

- a. System identification.
- b. Location.
- c. Coil type.
- d. Number of rows.
- e. Fin spacing in fins per inch o.c.
- f. Make and model number.
- g. Face area in sq. ft.
- h. Tube size in NPS.
- i. Tube and fin materials.
- j. Circuiting arrangement.

2. Test Data (Indicated and Actual Values):

- a. Airflow rate in cfm.
- b. Average face velocity in fpm.
- c. Air pressure drop in inches wg.
- d. Outdoor-air, wet- and dry-bulb temperatures in deg F.
- e. Return-air, wet- and dry-bulb temperatures in deg F.
- f. Entering-air, wet- and dry-bulb temperatures in deg F.
- g. Leaving-air, wet- and dry-bulb temperatures in deg F.
- h. Water flow rate in gpm.
- i. Water pressure differential in feet of head or psig.
- j. Entering-water temperature in deg F.
- k. Leaving-water temperature in deg F.
- l. Refrigerant expansion valve and refrigerant types.
- m. Refrigerant suction pressure in psig.
- n. Refrigerant suction temperature in deg F.
- o. Inlet steam pressure in psig.

G. Fan Test Reports: For supply, return, and exhaust fans, include the following:

1. Fan Data:
 - a. System identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and size.
 - e. Manufacturer's serial number.
 - f. Arrangement and class.
 - g. Sheave make, size in inches, and bore.
 - h. Center-to-center dimensions of sheave and amount of adjustments in inches.
2. Motor Data:
 - a. Motor make, and frame type and size.
 - b. Horsepower and rpm.
 - c. Volts, phase, and hertz.
 - d. Full-load amperage and service factor.
 - e. Sheave make, size in inches, and bore.
 - f. Center-to-center dimensions of sheave, and amount of adjustments in inches.
 - g. Number, make, and size of belts.
3. Test Data (Indicated and Actual Values):
 - a. Total airflow rate in cfm.
 - b. Total system static pressure in inches wg.
 - c. Fan rpm.
 - d. Discharge static pressure in inches wg.
 - e. Suction static pressure in inches wg.
- H. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:
 1. Report Data:
 - a. System and air-handling-unit number.
 - b. Location and zone.
 - c. Traverse air temperature in deg F.

- d. Duct static pressure in inches wg.
- e. Duct size in inches.
- f. Duct area in sq. ft..
- g. Indicated airflow rate in cfm.
- h. Indicated velocity in fpm.
- i. Actual airflow rate in cfm.
- j. Actual average velocity in fpm.
- k. Barometric pressure in psig.

I. Air-Terminal-Device Reports:

1. Unit Data:

- a. System and air-handling unit identification.
- b. Location and zone.
- c. Apparatus used for test.
- d. Area served.
- e. Make.
- f. Number from system diagram.
- g. Type and model number.
- h. Size.
- i. Effective area in sq. ft..

2. Test Data (Indicated and Actual Values):

- a. Airflow rate in cfm.
- b. Air velocity in fpm.
- c. Preliminary airflow rate as needed in cfm.
- d. Preliminary velocity as needed in fpm.
- e. Final airflow rate in cfm.
- f. Final velocity in fpm.
- g. Space temperature in deg F.

J. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:

1. Unit Data:

- a. System and air-handling-unit identification.
 - b. Location and zone.
 - c. Room or riser served.
 - d. Coil make and size.
 - e. Flowmeter type.
2. Test Data (Indicated and Actual Values):
 - a. Airflow rate in cfm.
 - b. Entering-water temperature in deg F.
 - c. Leaving-water temperature in deg F.
 - d. Water pressure drop in feet of head or psig.
 - e. Entering-air temperature in deg F.
 - f. Leaving-air temperature in deg F.

K. Instrument Calibration Reports:

1. Report Data:
 - a. Instrument type and make.
 - b. Serial number.
 - c. Application.
 - d. Dates of use.
 - e. Dates of calibration.

3.17 VERIFICATION OF TAB REPORT

- A. The TAB specialist's test and balance engineer shall conduct the inspection in the presence of Contracting Officer.
- B. Contracting Officer shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.
- C. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
- D. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.
- E. If TAB work fails, proceed as follows:

1. TAB specialists shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.
2. If the second final inspection also fails, Contracting Officer may contract the services of another TAB specialist to complete TAB work according to the Contract Documents and deduct the cost of the services from the original TAB specialist's final payment.
3. If the second verification also fails, design professional may contact AABC Headquarters regarding the AABC National Performance Guaranty.

F. Prepare test and inspection reports.

3.18 ADDITIONAL TESTS

- A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.
- B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

3.19 TAB PROCEDURES

3.19.1 TAB Water Distribution Systems

3.19.1.1 Chilled Water

Chilled water systems including chillers, condensers, cooling towers, pumps, coils, system balance valves and flow measuring devices.

For water chillers, report data as required by AABC, NEBB and TABB standard procedures, including refrigeration operational data.

3.19.1.2 Heating Hot Water

Heating hot water systems including boilers, hot water converters (e.g., heat exchangers), pumps, coils, system balancing valves and flow measuring devices.

3.19.1.3 Dual Temperature Water

Dual temperature water systems including boilers, converters, chillers, condensers, cooling towers, pumps, coils, and system balancing valves, and flow measuring devices.

3.19.2 Sound Measurement Work

3.19.2.1 Areas To Be Sound Measured

In the following spaces, measure and record the sound power level for each octave band listed in **ASHRAE HVAC APP IP HDBK** Noise Criteria:

- a. All HVAC mechanical rooms, including machinery spaces and other spaces

containing HVAC power drivers and power driven equipment.

b. All spaces sharing a common barrier with each mechanical room, including rooms overhead, rooms on the other side of side walls, and rooms beneath the mechanical room floor.

c. AHU No. 1 System: Rooms: 130 Executive Dining 3.19.2.2 Procedure

Measure sound levels in each room, when unoccupied except for the TAB team, with all HVAC systems that would cause sound readings in the room operating in their noisiest mode. Record the sound level in each octave band. Attempt to mitigate the sound level and bring the level to within the specified ASHRAE HVAC APP IP HDBK noise criteria goals, if such mitigation is within the TAB team's control. State in the report the ASHRAE HVAC APP IP HDBK noise criteria goals. If sound level cannot be brought into compliance, provide written notice of the deficiency to the Contractor for resolution or correction.

3.19.2.3 Timing

Measure sound levels at times prescribed by AABC or NEBB or TABB.

3.19.2.4 Meters

Measure sound levels with a sound meter complying with ASA S1.4, Type 1 or 2, and an octave band filter set complying with ASA S1.11 PART 1. Use measurement methods for overall sound levels and for octave band sound levels as prescribed by NEBB.

3.19.2.5 Calibration

Calibrate sound levels as prescribed by AABC or NEBB or TABB, except that calibrators emitting a sound pressure level tone of 94 dB at 1000 hertz (Hz) are also acceptable.

3.19.2.6 Background Noise Correction

Determine background noise component of room sound (noise) levels for each (of eight) octave bands as prescribed by AABC or NEBB or TABB.

3.19.3 TAB Work on Performance Tests Without Seasonal Limitations

3.19.3.1 Sound Measurements

Comply with the paragraph SOUND MEASUREMENT WORK, specifically, the requirement that a room must be operating in its noisiest mode at the time of sound measurements in the room. The maximum noise level measurements could depend on seasonally related heat or cooling transfer equipment.

3.20 MARKING OF SETTINGS

Upon the final TAB work approval, permanently mark the settings of HVAC adjustment devices including valves, gauges, splitters, and dampers so that adjustment can be restored if disturbed at any time. Provide permanent markings clearly indicating the settings on the adjustment devices which result in the data reported on the submitted TAB report.

3.21 MARKING OF TEST PORTS

The TAB team is to permanently and legibly mark and identify the location points of the duct test ports. If the ducts have exterior insulation, make these markings on the exterior side of the duct insulation. Show the location of test ports on the as-built mechanical drawings with dimensions given where the test port is covered by exterior insulation.

-- End of Section --

SECTION 23 07 00

THERMAL INSULATION FOR MECHANICAL SYSTEMS
02/13, CHG 7: 05/20

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only. At the discretion of the Government, the manufacturer of any material supplied will be required to furnish test reports pertaining to any of the tests necessary to assure compliance with the standard or standards referenced in this specification.

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING
ENGINEERS (ASHRAE)

ASHRAE 90.1 - SI (2019; Errata 1-4 2020; Addenda BY-CP 2020; Addenda AF-DB 2020; Addenda A-G 2020; Addenda F-Y 2021; Errata 5-7 2021; Interpretation 1-4 2020; Interpretation 5-8 2021; Addenda AU-CM 2022) Energy Standard for Buildings Except Low-Rise Residential Buildings

ASHRAE 90.2 (2020) Energy-Efficient Design of Low-Rise Residential Buildings

ASTM INTERNATIONAL (ASTM)

ASTM A167 (2011) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip

ASTM A240/A240M (2022b) Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications

ASTM A580/A580M (2018) Standard Specification for Stainless Steel Wire

ASTM B209 (2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate

ASTM C195 (2007; R 2013) Standard Specification for Mineral Fiber Thermal Insulating Cement

ASTM C450 (2008) Standard Practice for Fabrication of Thermal Insulating Fitting Covers for NPS Piping, and Vessel Lagging

ASTM C533 (2017) Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation

ASTM C534/C534M	(2020a) Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form
ASTM C547	(2022a) Standard Specification for Mineral Fiber Pipe Insulation
ASTM C552	(2022) Standard Specification for Cellular Glass Thermal Insulation
ASTM C585	(2010) Standard Practice for Inner and Outer Diameters of Thermal Insulation for Nominal Sizes of Pipe and Tubing
ASTM C592	(2022a) Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type)
ASTM C610	(2015) Standard Specification for Molded Expanded Perlite Block and Pipe Thermal Insulation
ASTM C612	(2014; R 2019) Standard Specification for Mineral Fiber Block and Board Thermal Insulation
ASTM C647	(2008; R 2013) Properties and Tests of Mastics and Coating Finishes for Thermal Insulation
ASTM C755	(2019b) Standard Practice for Selection of Water Vapor Retarders for Thermal Insulation
ASTM C795	(2008; R 2018) Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel
ASTM C916	(2020) Standard Specification for Adhesives for Duct Thermal Insulation
ASTM C920	(2018) Standard Specification for Elastomeric Joint Sealants
ASTM C921	(2010; R 2015) Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation
ASTM C1126	(2018) Standard Specification for Faced or Unfaced Rigid Cellular Phenolic Thermal Insulation
ASTM C1136	(2021) Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation
ASTM C1710	(2011) Standard Guide for Installation of

Flexible Closed Cell Preformed Insulation
in Tube and Sheet Form

ASTM D882	(2012) Tensile Properties of Thin Plastic Sheeting
ASTM D2863	(2019) Standard Test Method for Measuring the Minimum Oxygen Concentration to Support Candle-Like Combustion of Plastics (Oxygen Index)
ASTM D5590	(2000; R 2010; E 2012) Standard Test Method for Determining the Resistance of Paint Films and Related Coatings to Fungal Defacement by Accelerated Four-Week Agar Plate Assay
ASTM E84	(2020) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM E96/E96M	(2022a) Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials
ASTM E2231	(2021) Standard Practice for Specimen Preparation and Mounting of Pipe and Duct Insulation Materials to Assess Surface Burning Characteristics
ASTM E2336	(2020) Standard Test Methods for Fire Resistive Grease Duct Enclosure Systems

CALIFORNIA DEPARTMENT OF PUBLIC HEALTH (CDPH)

CDPH SECTION 01350	(2010; Version 1.1) Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources using Environmental Chambers

FM GLOBAL (FM)

FM APP GUIDE	(updated on-line) Approval Guide http://www.approvalguide.com/

GREEN SEAL (GS)

GS-36	(2013) Adhesives for Commercial Use

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS
INDUSTRY (MSS)

MSS SP-58	(2018) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation

MIDWEST INSULATION CONTRACTORS ASSOCIATION (MICA)

MICA Insulation Stds	(8th Ed) National Commercial & Industrial

Insulation Standards

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

- NFPA 90A** (2021) Standard for the Installation of Air Conditioning and Ventilating Systems
- NFPA 90B** (2021) Standard for the Installation of Warm Air Heating and Air Conditioning Systems
- NFPA 96** (2021) Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations

SCIENTIFIC CERTIFICATION SYSTEMS (SCS)

- SCS** SCS Global Services (SCS) Indoor Advantage

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT (SCAQMD)

- SCAQMD Rule 1168** (2017) Adhesive and Sealant Applications

TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY (TAPPI)

- TAPPI T403 OM** (2022) Bursting Strength of Paper

U.S. DEPARTMENT OF DEFENSE (DOD)

- MIL-A-3316** (1987; Rev C; Am 2 1990) Adhesives, Fire-Resistant, Thermal Insulation
- MIL-A-24179** (1969; Rev A; Am 2 1980; Notice 1 1987; Notice 2 2020) Adhesive, Flexible Unicellular-Plastic Thermal Insulation
- MIL-PRF-19565** (1988; Rev C) Coating Compounds, Thermal Insulation, Fire- and Water-Resistant, Vapor-Barrier

UNDERWRITERS LABORATORIES (UL)

- UL 94** (2013; Reprint Apr 2022) UL Standard for Safety Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
- UL 723** (2018) UL Standard for Safety Test for Surface Burning Characteristics of Building Materials
- UL 2818** (2013) GREENGUARD Certification Program For Chemical Emissions For Building Materials, Finishes And Furnishings

1.2 SYSTEM DESCRIPTION

1.2.1 General

Provide field-applied insulation and accessories on mechanical systems as specified herein; factory-applied insulation is specified under the piping, duct or equipment to be insulated. Provide insulation of heat distribution systems and chilled water systems outside of buildings. specified in Section

Furnish and install field applied insulation materials required for use on Government-furnished items as listed in the SPECIAL CONTRACT REQUIREMENTS.

1.3 SUBMITTALS

Government approval is required for submittals. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

Submit the three SD types, SD-02 Shop Drawings, SD-03 Product Data, and SD-08 Manufacturer's Instructions at the same time for each system.

SD-02 Shop Drawings

MICA Plates;

Pipe Insulation Systems and Associated Accessories

Duct Insulation Systems and Associated Accessories

Equipment Insulation Systems and Associated Accessories

Recycled content for insulation materials;

SD-03 Product Data

Pipe Insulation Systems;

Duct Insulation Systems;

Equipment Insulation Systems;

SD-04 Samples

Thermal Insulation;

Display Samples;

SD-07 Certificates

Indoor air quality for adhesives;

SD-08 Manufacturer's Instructions

Pipe Insulation Systems;

Duct Insulation Systems;

Equipment Insulation Systems;

1.4 CERTIFICATIONS

1.4.1 Adhesives and Sealants

Provide products certified to meet indoor air quality requirements by **UL 2818** (Greenguard) Gold, **SCS** Global Services Indoor Advantage Gold or provide certification or validation by other third-party programs that products meet the requirements of this Section. Provide current product certification documentation from certification body. When product does not have certification, provide validation that product meets the indoor air quality product requirements cited herein.

1.5 QUALITY ASSURANCE

1.5.1 Installer Qualification

Qualified installers will have successfully completed three or more similar type jobs within the last 5 years.

1.6 DELIVERY, STORAGE, AND HANDLING

Deliver materials in the manufacturer's unopened containers. Protect materials delivered and placed in storage from weather, humidity, dirt, dust and other contaminants. The Contracting Officer may reject insulation material and supplies that become dirty, dusty, wet, or contaminated by some other means. Attach manufacturer's stamp or label giving the name of the manufacturer and brand, and a description of the material, date codes, and approximate shelf life (if applicable) to packages or standard containers of insulation, jacket material, cements, adhesives, and coatings delivered for use, and samples required for approval. Insulation packages and containers must be asbestos free.

PART 2 PRODUCTS

2.1 STANDARD PRODUCTS

Provide materials which are the standard products of manufacturers regularly engaged in the manufacture of such products and that essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Submit a complete list of materials, including manufacturer's descriptive technical literature, performance data, catalog cuts, and installation instructions. Include the product number, k-value, thickness and furnished accessories including adhesives, sealants and jackets for each mechanical system requiring insulation. The product data must be copyrighted, have an identifying or publication number, and have been published prior to the issuance date of this solicitation. Submit materials furnished under this section together in a booklet.

2.1.1 Insulation System

Provide insulation systems in accordance with the approved MICA National Insulation Standards plates as supplemented by this specification. Provide field-applied insulation for heating, ventilating, and cooling (HVAC) air distribution systems and piping systems that are located within, on, under, and adjacent to buildings; and for plumbing systems. Provide CFC and HCFC free insulation.

2.1.2 Surface Burning Characteristics

Unless otherwise specified, insulation must have a maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with [ASTM E84](#). Determine flame spread, and smoke developed indexes, by [ASTM E84](#) or [UL 723](#). Test insulation in the same density and installed thickness as the material to be used in the actual construction. Prepare and mount test specimens according to [ASTM E2231](#).

2.2 MATERIALS

Provide insulation that meets or exceeds the requirements of [ASHRAE 90.2](#). Ensure insulation exterior is cleanable, grease resistant, non-flaking and non-peeling. Provide compatible materials that do not contribute to corrosion, soften, or otherwise attack surfaces to which applied in either wet or dry state. Use materials on stainless steel surfaces meeting [ASTM C795](#) requirements. Do not use calcium silicate on chilled or cold water systems. Use asbestos free materials. Provide product recognized under [UL 94](#) (if containing plastic) and listed in [FM APP GUIDE](#).

2.2.1 Adhesives

Provide non-aerosol adhesive products used on the interior of the building (defined as inside of the weatherproofing system) that meet either emissions requirements of [CDPH SECTION 01350](#) (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of [SCAQMD Rule 1168](#) (HVAC duct sealants must meet limit requirements of "Other" category within [SCAQMD Rule 1168](#) sealants table). Provide aerosol adhesives used on the interior of the building that meet either emissions requirements of [CDPH SECTION 01350](#) (use the office or classroom requirements, regardless of space type) or VOC content requirements of [GS-36](#). Provide certification or validation of [indoor air quality for adhesives](#).

2.2.1.1 Acoustical Lining Insulation Adhesive

Provide a nonflammable, fire-resistant adhesive conforming to [ASTM C916](#), Type I.

2.2.1.2 Mineral Fiber Insulation Cement

Provide cement in accordance with [ASTM C195](#).

2.2.1.3 Lagging Adhesive

Lagging is the material used for [thermal insulation](#), especially around a cylindrical object. This may include the insulation as well as the cloth/material covering the insulation. To resist mold/mildew, use lagging adhesive meeting [ASTM D5590](#) with 0 growth rating. Provide nonflammable and fire-resistant lagging adhesives that have a maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with [ASTM E84](#). Ensure adhesive is [MIL-A-3316](#), Class 1, pigmented white and suitable for bonding fibrous glass cloth to faced and unfaced fibrous glass insulation board; for bonding cotton brattice cloth to faced and unfaced fibrous glass insulation board; for sealing edges of and bonding glass tape to joints of fibrous glass board; for bonding lagging cloth to thermal insulation; or Class 2 for attaching fibrous glass insulation to metal surfaces. Apply lagging adhesives in strict accordance with the manufacturer's recommendations for pipe and

duct insulation.

2.2.1.4 Contact Adhesive

Adhesives may be any of, but not limited to, the neoprene based, rubber based, or elastomeric type that have a maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with [ASTM E84](#). Ensure adhesive does not adversely affect, initially or in service, the insulation to which it is applied, nor cause any corrosive effect on metal to which it is applied. Ensure that any solvent dispersing medium or volatile component of the adhesive has no objectionable odor and does not contain any benzene or carbon tetrachloride. Ensure dried adhesive does not emit nauseous, irritating, or toxic volatile matters or aerosols when the adhesive is heated to any temperature up to [212 degrees F](#). The dried adhesive must be nonflammable and fire resistant. Flexible Elastomeric Adhesive: Comply with [MIL-A-24179](#), Type II, Class I. Provide product listed in [FM APP GUIDE](#).

2.2.2 Caulking

[ASTM C920](#), Type S, Grade NS, Class 25, Use A.

2.2.3 Corner Angles

Nominal [0.016 inch](#) aluminum [1 by 1 inch](#) with factory applied kraft backing. Aluminum must be [ASTM B209](#), Alloy 3003, 3105, or 5005.

2.2.4 Fittings

Fabricated Fittings are the prefabricated fittings for flexible elastomeric pipe insulation systems in accordance with [ASTM C1710](#). Together with the flexible elastomeric tubes, they provide complete system integrity for retarding heat gain and controlling condensation drip from chilled-water and refrigeration systems. Flexible elastomeric, fabricated fittings provide thermal protection (0.25 k) and condensation resistance (0.05 Water Vapor Transmission factor). For satisfactory performance, use properly installed protective vapor retarder/barriers and vapor stops on high relative humidity and below ambient temperature applications to reduce movement of moisture through or around the insulation to the colder interior surface.

2.2.5 Finishing Cement

[ASTM C450](#): Mineral fiber hydraulic-setting thermal insulating and finishing cement. All cements that may come in contact with Austenitic stainless steel must comply with [ASTM C795](#).

2.2.6 Fibrous Glass Cloth and Glass Tape

Provide fibrous glass cloth, with 20X20 maximum mesh size, and glass tape with maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with [ASTM E84](#). Provide tape consisting of [4 inch](#) wide rolls. Provide Class 3 tape that is [4.5 ounces/square yard](#). Elastomeric Foam Tape: Black vapor-retarder foam tape with acrylic adhesive containing an anti-microbial additive.

2.2.7 Staples

Outward clinching type [ASTM A167](#), Type 304 or 316 stainless steel.

2.2.8 Jackets

2.2.8.1 Aluminum Jackets

Provide aluminum jackets consisting of corrugated, embossed or smooth sheet, 0.016 inch nominal thickness; ASTM B209, Temper H14, Temper H16, Alloy 3003, 5005, or 3105. Do not use corrugated aluminum jacket outdoors. Aluminum jacket securing bands must be Type 304 stainless steel, 0.015 inch thick, 1/2 inch wide for pipe under 12 inch diameter and 3/4 inch wide for pipe over 12 inch and larger diameter. Aluminum jacket circumferential seam bands must be 2 by 0.016 inch aluminum matching jacket material. Ensure bands for insulation below ground are 3/4 by 0.020 inch thick stainless steel, or fiberglass reinforced tape. The jacket may, at the option of the Contractor, be provided with a factory fabricated Pittsburgh or "Z" type longitudinal joint. When the "Z" joint is used, use bands at the circumferential joints that are designed by the manufacturer to seal the joints and hold the jacket in place.

2.2.8.2 Polyvinyl Chloride (PVC) Jackets

Polyvinyl chloride (PVC) jacket and fitting covers must have high impact strength, ultraviolet (UV) resistant rating or treatment and moderate chemical resistance with minimum thickness 0.030 inch.

2.2.8.3 Vapor Barrier/Weatherproofing Jacket

Provide laminated self-adhesive vapor barrier/weatherproofing jacket, greater than 3 plies standard grade, silver, white, black and embossed or greater than 8 ply (minimum 2.9 mils adhesive); with 0.0000 permeability when tested in accordance with ASTM E96/E96M, using the water transmission rate test method; heavy duty, white or natural; and UV resistant. Flexible Elastomeric exterior foam with factory applied, UV Jacket made with a cold weather acrylic adhesive. Construction of laminate designed to provide UV resistance, high puncture, tear resistance and excellent Water Vapor Transmission (WVT) rate.

2.2.8.4 Vapor Barrier/Vapor Retarder

Apply the following criteria to determine which system is required.

- a. On ducts, equip piping and equipment operating below 50 degrees F or located outside with a vapor barrier.
- b. Install ducts, pipes and equipment that are located inside and that always operate above 50 degrees F with a vapor retarder where required as stated in paragraph VAPOR RETARDER REQUIRED.

2.2.9 Vapor Retarder Required

ASTM C921, Type I, minimum puncture resistance 50 Beach units on all surfaces except concealed ductwork, where a minimum puncture resistance of 25 Beach units is acceptable. Minimum tensile strength, 35 pounds/inch width. ASTM C921, Type II, minimum puncture resistance 25 Beach units, tensile strength minimum 20 pounds/inch width. Use jackets on insulation exposed in finished areas that have white finish suitable for painting without sizing. Based on the application, insulation materials that require manufacturer or fabricator applied pipe insulation jackets are

cellular glass, when all joints are sealed with a vapor barrier mastic, and mineral fiber. Ensure all non-metallic jackets have a maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with [ASTM E84](#). Flexible elastomerics require (in addition to vapor barrier skin) vapor retarder jacketing for high relative humidity and below ambient temperature applications.

2.2.9.1 White Vapor Retarder All Service Jacket (ASJ)

ASJ is for use on hot/cold pipes, ducts, or equipment indoors or outdoors if covered by a suitable protective jacket. Provide product which meets all physical property and performance requirements of [ASTM C1136](#), Type I, except a minimum burst strength of 85 psi. [ASTM D2863](#) Limited Oxygen Index (LOI) is a minimum of 31.

In addition, do not use paper or other moisture-sensitive material for the outer exposed surface or the inner-most surface contacting the insulation. Ensure the outer exposed surface is white and has an emittance no less than 0.80. Ensure the outer exposed surface is paintable.

2.2.9.2 Vapor Retarder/Vapor Barrier Mastic Coatings

2.2.9.2.1 Vapor Barrier

The vapor barrier must be self adhesive (minimum 2 mils adhesive, 3 mils embossed) greater than 3 plies standard grade, silver, white, black and embossed white jacket for use on hot/cold pipes. Ensure permeability is less than 0.02 when tested in accordance with [ASTM E96/E96M](#). Provide products meeting [UL 723](#) or [ASTM E84](#) flame and smoke requirements and that are UV resistant.

2.2.9.2.2 Vapor Retarder

Provide fire and water resistant vapor retarder coating appropriately selected for either outdoor or indoor service. Color must be white. Ensure the water vapor permeance of the compound is in accordance with [ASTM C755](#), Section 7.2.2, Table 2, for insulation type and service conditions. Provide nonflammable, fire resistant coating. To resist mold/mildew, provide coating meeting [ASTM D5590](#) with 0 growth rating. Ensure coating meets [MIL-PRF-19565](#) Type II (if selected for indoor service) and is Qualified Products Database listed. Determine all other application and service properties pursuant to [ASTM C647](#).

2.2.9.3 Laminated Film Vapor Retarder

[ASTM C1136](#), Type I, maximum moisture vapor transmission 0.02 perms, minimum puncture resistance 50 Beach units on all surfaces except concealed ductwork; where Type II, maximum moisture vapor transmission 0.02 perms, a minimum puncture resistance of 25 Beach units is acceptable. Provide vapor retarder with a maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with [ASTM E84](#). Flexible Elastomeric exterior foam with factory applied UV Jacket. Construction of laminate designed to provide UV resistance, high puncture, tear resistance and an excellent WVT rate.

2.2.9.4 Polyvinylidene Chloride (PVDC) Film Vapor Retarder

Provide PVDC film vapor retarder with a maximum moisture vapor

transmission of 0.02 perms, minimum puncture resistance of 150 Beach units, a minimum tensile strength in any direction of 30 lb/inch when tested in accordance with ASTM D882, and a maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with ASTM E84.

2.2.9.5 Polyvinylidene Chloride Vapor Retarder Adhesive Tape

Requirements must meet the same as specified for Laminated Film Vapor Retarder above.

2.2.9.6 Vapor Barrier/Weather Barrier

Ensure the vapor barrier is greater than 3 ply self adhesive laminate -white vapor barrier jacket- superior performance (less than 0.0000 permeability when tested in accordance with ASTM E96/E96M). Provide vapor barrier meeting UL 723 or ASTM E84 25 flame and 50 smoke requirements; and UV resistant. Minimum burst strength 185 psi in accordance with TAPPI T403 OM. Tensile strength 68 lb/inch width (PSTC-1000). Provide tape as specified for laminated film vapor barrier above.

2.2.10 Vapor Retarder Not Required

ASTM C921, Type II, Class D, minimum puncture resistance 50 Beach units on all surfaces except ductwork, where Type IV, maximum moisture vapor transmission 0.10, a minimum puncture resistance of 25 Beach units is acceptable. Provide jacket with a maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with ASTM E84.

2.2.11 Wire

Soft annealed ASTM A580/A580M Type 302, 304 or 316 stainless steel, 16 or 18 gauge.

2.2.12 Insulation Bands

Provide 1/2 inch wide; 26 gauge stainless steel insulation bands.

2.2.13 Sealants

Choose sealants from the butyl polymer type, the styrene-butadiene rubber type, or the butyl type of sealants. Provide sealants with a maximum permeance of 0.02 perms based on Procedure B for ASTM E96/E96M, and a maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with ASTM E84.

2.3 PIPE INSULATION SYSTEMS

Conform insulation materials to Table 1 and minimum insulation thickness as listed in Table 2 and meet or exceed the requirements of ASHRAE 90.1 - SI. Limit pipe insulation materials to those listed herein and meeting the following requirements:

2.3.1 Recycled Materials

Provide insulation materials containing the following minimum percentage of recycled material content by weight:

Rock Wool: 75 percent slag of weight

Fiberglass: 20 percent glass cullet
Rigid Foam: 9 percent recovered material
Phenolic Rigid Foam: 9 percent recovered material

Provide data identifying percentage of [recycled content for insulation materials](#).

2.3.2 Aboveground Cold Pipeline ([-30 to 60 deg. F](#))

Provide insulation for outdoor, indoor, exposed or concealed applications, as follows:

2.3.2.1 Cellular Glass

[ASTM C552](#), Type II, and Type III. Supply the insulation from the fabricator with (paragraph WHITE VAPOR RETARDER ALL SERVICE JACKET (ASJ)) ASJ vapor retarder and installed with all longitudinal overlaps sealed and all circumferential joints ASJ taped or supply the insulation unfaced from the fabricator and install with all longitudinal and circumferential joints sealed with vapor barrier mastic.

2.3.2.2 Flexible Elastomeric Cellular Insulation

Closed-cell, foam- or expanded-rubber materials containing anti-microbial additive, complying with [ASTM C534/C534M](#), Grade 1, Type I or II. Type I, Grade 1 for tubular materials. Type II, Grade 1, for sheet materials. Ensure Type I and II have vapor retarder/vapor barrier skin on one or both sides of the insulation, and require an additional exterior vapor retarder covering for high relative humidity and below ambient temperature applications.

2.3.3 Aboveground Hot Pipeline (Above [60 deg. F](#))

Provide insulation for outdoor, indoor, exposed or concealed applications meeting the following requirements. Supply the insulation with manufacturer's recommended factory-applied jacket/vapor barrier.

2.3.3.1 Mineral Fiber

[ASTM C547](#), Types I, II or III, supply the insulation with manufacturer's recommended factory-applied jacket.

2.3.3.2 Flexible Elastomeric Cellular Insulation

Closed-cell, foam- or expanded-rubber materials containing anti-microbial additive, complying with [ASTM C534/C534M](#), Grade 1, Type I or II to [220 degrees F](#) service. Type I for tubular materials. Type II for sheet materials.

2.4 DUCT INSULATION SYSTEMS

2.4.1 Factory Applied Insulation

Provide factory-applied [ASTM C534/C534M](#) Grade 1, Type II, flexible elastomeric closed cell insulation according to manufacturer's recommendations for insulation with insulation manufacturer's standard reinforced fire-retardant vapor barrier, with identification of installed thermal resistance (R) value and out-of-package R value.

2.4.1.1 Rigid Insulation

Calculate the minimum thickness in accordance with **ASHRAE 90.2**.

2.4.1.2 Blanket Insulation

Calculate minimum thickness in accordance with **ASHRAE 90.2**.

2.4.2 Kitchen Exhaust Ductwork Insulation

Refer to Drawings for insulation type and thickness. Provide enclosure materials and grease duct enclosure systems which meet testing requirements of **ASTM E2336** for noncombustibility, fire resistance, durability, internal fire, and fire-engulfment with a through-penetration fire stop.

2.4.3 Acoustical Duct Lining

2.4.3.1 General

For ductwork indicated or specified in Section **23 30 00** HVAC AIR DISTRIBUTION to be acoustically lined, provide external insulation in accordance with this specification section and in addition to the acoustical duct lining. Do not use acoustical lining in place of duct wrap or rigid board insulation (insulation on the exterior of the duct).

2.4.3.2 Duct Liner

Flexible Elastomeric Acoustical and Conformable Duct Liner Materials: Flexible Elastomeric Thermal, Acoustical and Conformable Insulation Compliance with **ASTM C534/C534M** Grade 1, Type II; and **NFPA 90A** or **NFPA 90B** as applicable.

2.4.4 Duct Insulation Jackets

2.4.4.1 All-Purpose Jacket

Provide insulation with insulation manufacturer's standard reinforced fire-retardant jacket with or without integral vapor barrier as required by the service. In exposed locations, provide jacket with a white surface suitable for field painting.

2.4.4.2 Metal Jackets

2.4.4.2.1 Aluminum Jackets

ASTM B209, Temper H14, minimum thickness of 27 gauge (**0.016 inch**), with factory-applied polyethylene and kraft paper moisture barrier on inside surface. Provide smooth surface jackets for jacket outside dimension **8 inches** and larger. Provide corrugated surface jackets for jacket outside dimension **8 inches** and larger. Provide stainless steel bands, minimum width of **1/2 inch**.

2.4.4.2.2 Stainless Steel Jackets

ASTM A167 or **ASTM A240/A240M**; Type 304, minimum thickness of 33 gauge (**0.010 inch**), smooth surface with factory-applied polyethylene and kraft paper moisture barrier on inside surface. Provide stainless steel bands, minimum width of **1/2 inch**.

2.4.4.3 Vapor Barrier/Weatherproofing Jacket

Provide vapor barrier/weatherproofing jacket that is laminated self-adhesive (minimum 2 mils adhesive, 3 mils embossed) less than 0.0000 permeability, (greater than 3 ply, standard grade, silver, white, black and embossed or greater than 8 ply (minimum 2.9 mils adhesive), heavy duty white or natural).

2.4.5 Weatherproof Duct Insulation

Provide ASTM C534/C534M Grade 1, Type II, flexible elastomeric cellular insulation, and weatherproofing as specified in manufacturer's instruction. Multi-ply, Polymeric Blend Laminate Jacketing: Construction of laminate designed to provide UV resistance, high puncture, tear resistance and an excellent WVT rate.

2.5 EQUIPMENT INSULATION SYSTEMS

Insulate equipment and accessories as specified in Tables 5 and 6. In outside locations, provide insulation 1/2 inch thicker than specified. Increase the specified insulation thickness for equipment where necessary to equal the thickness of angles or other structural members to make a smooth, exterior surface. Submit a booklet containing manufacturer's published installation instructions for the insulation systems. The instructions must be copyrighted, have an identifying or publication number, and have been published prior to the issuance date of this solicitation. A booklet is also required by paragraphs titled: Pipe Insulation Systems and Duct Insulation Systems.

PART 3 EXECUTION

3.1 APPLICATION - GENERAL

Apply insulation to unheated and uncooled piping and equipment. Do not compress flexible elastomeric cellular insulation at joists, studs, columns, ducts, and hangers. The insulation must not pull apart after a one hour period; replace any insulation found to pull apart after one hour.

3.1.1 Display Samples

Submit and display, after approval of materials, actual sections of installed systems, properly insulated in accordance with the specification requirements. Such actual sections must remain accessible to inspection throughout the job and will be reviewed from time to time for controlling the quality of the work throughout the construction site. Identify each material used by indicating on an attached sheet the specification requirement for the material and the material by each manufacturer intended to meet the requirement. The Contracting Officer will inspect display sample sections at the jobsite. Keep approved display sample sections on display at the jobsite during the construction period. Upon completion of construction, the display sample sections will be closed and sealed.

3.1.1.1 Pipe Insulation Display Sections

Include as a minimum an elbow or tee, a valve, dielectric waterways and flanges, a hanger with protection shield and insulation insert, or dowel as required, at support point, method of fastening and sealing insulation

at longitudinal lap, circumferential lap, butt joints at fittings and on pipe runs, and terminating points for each type of pipe insulation used on the job, and for hot pipelines and cold pipelines, both interior and exterior, even when the same type of insulation is used for these services.

3.1.1.2 Duct Insulation Display Sections

Display sample sections for rigid and flexible duct insulation used on the job. Use a temporary covering to enclose and protect display sections for duct insulation exposed to weather

3.1.2 Installation

Except as otherwise specified, install material in accordance with the manufacturer's written instructions. Do not apply insulation materials until tests specified in other sections of this specification are completed. Remove material such as rust, scale, dirt and moisture from surfaces to receive insulation. Keep insulation clean and dry. Do not remove insulation from its shipping containers until the day it is ready to use and return to like containers or equally protect from dirt and moisture at the end of each workday. Thoroughly clean insulation that becomes dirty prior to use. If insulation becomes wet or if cleaning does not restore the surfaces to like new condition, reject the insulation, and immediately remove from the jobsite. Stagger joints on multi layer insulation. Mix mineral fiber thermal insulating cement with demineralized water when used on stainless steel surfaces. Install insulation, jacketing and accessories in accordance with **MICA Insulation Std**s plates except where modified herein or on the drawings.

3.1.3 Firestopping

Where **pipes** and **ducts** pass through fire walls, fire partitions, above grade floors, and fire rated chase walls, seal the penetration with fire stopping materials as specified in Section **07 84 00** FIRESTOPPING. The protection of ducts at point of passage through firewalls must be in accordance with **NFPA 90A** and/or **NFPA 90B**. All other penetrations, such as piping, conduit, and wiring, through firewalls must be protected with a material or system of the same hourly rating that is listed by UL, FM, or a NRTL.

3.1.4 Painting and Finishing

Paint as specified in Section **09 90 00** PAINTS AND COATINGS.

3.1.5 Installation of Flexible Elastomeric Cellular Insulation

Install flexible elastomeric cellular insulation with seams and joints sealed with rubberized contact adhesive. Do not use flexible elastomeric cellular insulation on surfaces greater than **220 degrees F**. Stagger seams when applying multiple layers of insulation. Protect insulation exposed to weather and not shown to have vapor barrier weatherproof jacketing with two coats of UV resistant finish or PVC or metal jacketing as recommended by the manufacturer after the adhesive is dry and cured.

3.1.5.1 Adhesive Application

Apply a brush coating of adhesive to both butt ends to be joined and to both slit surfaces to be sealed. Allow the adhesive to set until dry to

touch but tacky under slight pressure before joining the surfaces. Ensure insulation seals at seams and joints are not capable of being pulled apart one hour after application. Replace insulation that can be pulled apart one hour after installation.

3.1.5.2 Adhesive Safety Precautions

Use natural cross-ventilation, local (mechanical) pickup, and/or general area (mechanical) ventilation to prevent an accumulation of solvent vapors, keeping in mind the ventilation pattern must remove any heavier-than-air solvent vapors from lower levels of the workspaces. Gloves and spectacle-type safety glasses are recommended in accordance with safe installation practices.

3.1.6 Welding

Welding is not permitted on piping, duct or equipment without written approval of the Contracting Officer. The capacitor discharge welding process may be used for securing metal fasteners to duct.

3.1.7 Pipes/Ducts/Equipment That Require Insulation

Insulation is required on all pipes, ducts, or equipment, except for omitted items as specified.

3.2 PIPE INSULATION SYSTEMS INSTALLATION

3.2.1 Pipe Insulation

3.2.1.1 General

Install pipe insulation on aboveground hot and cold pipeline systems as specified below to form a continuous thermal retarder/barrier, including straight runs, fittings and appurtenances unless specified otherwise. Install full length units of insulation using a single cut piece to complete a run. Do not use cut pieces or scraps abutting each other. Omit pipe insulation on the following:

- a. Pipe used solely for fire protection.
- b. Chromium plated pipe to plumbing fixtures. However, for fixtures used by the physically handicapped, insulate the hot water supply and drain, including the trap, where exposed.
- c. Sanitary drain lines.
- d. Air chambers.
- e. Adjacent insulation.
- f. ASME stamps.
- g. Access plates of fan housings.
- h. Cleanouts or handholes.

3.2.1.2 Pipes Passing Through Walls, Roofs, and Floors

Provide continuous pipe insulation through the sleeve.

Provide an aluminum jacket or vapor barrier/weatherproofing self adhesive jacket (minimum 2 mils adhesive, 3 mils embossed) less than 0.0000 permeability, greater than 3 ply standard grade, silver, white, black and embossed with factory applied moisture retarder over the insulation wherever penetrations require sealing.

3.2.1.2.1 Penetrate Interior Walls

Provide aluminum jacket or vapor barrier/weatherproofing - self adhesive jacket (minimum 2 mils adhesive, 3 mils embossed) less than 0.0000 permeability, greater than 3 plies standard grade, silver, white, black and embossed which extends 2 inches beyond either side of the wall and secure on each end with a band.

3.2.1.2.2 Penetrating Floors

Extend the aluminum jacket from a point below the backup material to a point 10 inches above the floor with one band at the floor and one not more than 1 inch from the end of the aluminum jacket.

3.2.1.2.3 Penetrating Waterproofed Floors

Extend the aluminum jacket from below the backup material to a point 2 inches above the flashing with a band 1 inch from the end of the aluminum jacket.

3.2.1.2.4 Penetrating Exterior Walls

Continue the aluminum jacket required for pipe exposed to weather through the sleeve to a point 2 inches beyond the interior surface of the wall.

3.2.1.2.5 Penetrating Roofs

Insulate pipe as required for interior service to a point flush with the top of the flashing and sealed with flashing sealant. Tightly butt the insulation for exterior application to the top of flashing and interior insulation. Extend the exterior aluminum jacket 2 inches down beyond the end of the insulation to form a counter flashing. Seal the flashing and counter flashing underneath with metal jacketing/flashing sealant.

3.2.1.2.6 Hot Water Pipes Supplying Lavatories or Other Similar Heated Service

Terminate the insulation on the backside of the finished wall. Protect the insulation termination with two coats of vapor barrier coating with a minimum total thickness of 1/16 inch applied with glass tape embedded between coats (if applicable). Extend the coating out onto the insulation 2 inches and seal the end of the insulation. Overlap glass tape seams 1 inch. Caulk the annular space between the pipe and wall penetration with approved fire stop material. Cover the pipe and wall penetration with a properly sized (well fitting) escutcheon plate. Ensure the escutcheon plate overlaps the wall penetration at least 3/8 inches.

3.2.1.2.7 Domestic Cold Water Pipes Supplying Lavatories or Other Similar Cooling Service

Terminate the insulation on the finished side of the wall (i.e., insulation must cover the pipe throughout the wall penetration). Protect the insulation with two coats of weather barrier mastic (breather emulsion type weatherproof mastic impermeable to water and permeable to air) with a minimum total thickness of 1/16 inch. Extend the mastic out onto the insulation 2 inches and seal the end of the insulation. The annular space between the outer surface of the pipe insulation and caulk the wall penetration with an approved fire stop material having vapor retarder properties. Cover the pipe and wall penetration with a properly sized (well fitting) escutcheon plate. Ensure the escutcheon plate overlaps the wall penetration by at least 3/8 inches.

3.2.1.3 Pipes Passing Through Hangers

Ensure insulation, whether hot or cold application, is continuous through hangers. Support all horizontal pipes 2 inches and smaller on hangers with the addition of a Type 40 protection shield to protect the insulation in accordance with MSS SP-58. Whenever insulation shows signs of being compressed, or when the insulation or jacket shows visible signs of distortion at or near the support shield, install insulation inserts as specified below for piping larger than 2 inches, or factory insulated hangers (designed with a load bearing core) can be used.

3.2.1.3.1 Horizontal Pipes Larger Than 2 Inches at 60 Degrees F and Above

Supported on hangers in accordance with MSS SP-58, and Section 22 00 00 PLUMBING, GENERAL PURPOSE.

3.2.1.3.2 Horizontal Pipes Larger Than 2 Inches and Below 60 Degrees F

Supported on hangers with the addition of a Type 40 protection shield in accordance with MSS SP-58. Install an insulation insert of cellular glass, prefabricated insulation pipe hangers, or perlite above 80 degrees F above each shield. Ensure insert covers no less than the bottom 180-degree arc of the pipe. Provide inserts that are the same thickness as the insulation, and extend 2 inches on each end beyond the protection shield. When insulation inserts are required in accordance with the above, and the insulation thickness is less than 1 inch, wooden or cork dowels or blocks may be installed between the pipe and the shield to prevent the weight of the pipe from crushing the insulation, as an option to installing insulation inserts. Ensure the insulation jacket is continuous over the wooden dowel, wooden block, or insulation insert.

3.2.1.3.3 Vertical Pipes

Supported with either Type 8 or Type 42 riser clamps with the addition of two Type 40 protection shields in accordance with MSS SP-58 covering the 360-degree arc of the insulation. Install an insulation insert of cellular glass or calcium silicate between each shield and the pipe. Ensure the insert covers the 360-degree arc of the pipe. Provide inserts that are the same thickness as the insulation, and extend 2 inches on each end beyond the protection shield. When insulation inserts are required in accordance with the above, and the insulation thickness is less than 1 inch, wooden or cork dowels or blocks may be installed between the pipe and the shield to prevent the hanger from crushing the insulation, as an option instead of installing insulation inserts. Ensure the insulation jacket is

continuous over the wooden dowel, wooden block, or insulation insert. Support the vertical weight of the pipe with hangers located in a horizontal section of the pipe. When the pipe riser is longer than 30 feet, support the weight of the pipe additionally with hangers in the vertical run of the pipe that are directly clamped to the pipe, penetrating the pipe insulation. Use insulated hangers and seal the insulation jacket as indicated herein for anchors in a similar service.

3.2.1.3.4 Inserts

Covered with a jacket material of the same appearance and quality as the adjoining pipe insulation jacket, overlap the adjoining pipe jacket 1-1/2 inches, and seal as required for the pipe jacket. Use jacket material to cover inserts in flexible elastomeric cellular insulation conforming to ASTM C1136, Type 1, and is allowed to be of a different material than the adjoining insulation material.

3.2.1.4 Flexible Elastomeric Cellular Pipe Insulation

Use tubular form flexible elastomeric cellular pipe insulation for pipe sizes 6 inches and less. Grade 1, Do not stretch Type II sheet insulation used on pipes larger than 6 inches around the pipe. On pipes larger than 12 inches, adhere the insulation directly to the pipe on the lower 1/3 of the pipe. Stagger seams when applying multiple layers of insulation. Insulate sweat fittings with miter-cut pieces the same size as on adjacent piping. Insulate screwed fittings with sleeved fitting covers fabricated from miter-cut pieces and overlap and seal to the adjacent pipe insulation. Type II requires an additional exterior vapor retarder/barrier covering for high relative humidity and below ambient temperature applications.

3.2.1.5 Pipes in high abuse areas.

In high abuse areas such as janitor closets and traffic areas in equipment rooms, kitchens, and mechanical rooms, utilize stainless steel, aluminum or flexible laminate cladding (comprised of elastomeric, plastic or metal foil laminate) laminated self-adhesive (minimum 2 mils adhesive, 3 mils embossed) vapor barrier/weatherproofing jacket, - less than 0.0000 permeability; (greater than 3 ply, standard grade, silver, white, black and embossed) aluminum jackets. Protect pipe insulation to the 6 foot level.

3.2.1.6 Pipe Insulation Material and Thickness

Pipe insulation materials must be as listed in Table 1 and must meet or exceed the requirements of ASHRAE 90.1.

TABLE 1					
Insulation Material for Piping					
Service					
	Material	Specification	Type	Class	VR/VB Req'd
Chilled Water (Supply & Return, Dual Temperature Piping, 40 F nominal)					
	Cellular Glass	ASTM C552	II	2	Yes

TABLE 1					
Insulation Material for Piping					
Service					
	Material	Specification	Type	Class	VR/VB Req'd
	Flexible Elastomeric Cellular	ASTM C534/C534M	I		Yes
Heating Hot Water Supply & Return, Heated Oil (Max 250 F)					
	Mineral Fiber	ASTM C547	I	1	No
Cold Domestic Water Piping, Makeup Water & Drinking Fountain Drain Piping					
	Cellular Glass	ASTM C552	II	2	No
	Flexible Elastomeric Cellular	ASTM C534/C534M	I		No
Hot Domestic Water Supply & Recirculating Piping (Max 200 F)					
	Mineral Fiber	ASTM C547	I	1	No
	Cellular Glass	ASTM C552	II	2	No
	Flexible Elastomeric Cellular	ASTM C534/C534M	I		No
	Faced Phenolic Foam	ASTM C1126	III		Yes
Refrigerant Suction Piping (35 degrees F nominal)					
	Flexible Elastomeric Cellular	ASTM C534/C534M	I		No
	Cellular Glass	ASTM C552	II	1	Yes
Compressed Air Discharge, Steam and Condensate Return (201 to 250 Degrees F)					
	Cellular Glass	ASTM C552	II		No
	Mineral Fiber	ASTM C547	I	1	No
	Calcium Silicate	ASTM C533	I		No
	Faced Phenolic Foam	ASTM C1126	III		Yes
	Perlite	ASTM C610			No
	Flexible Elastomeric Cellular	ASTM C534/C534M	I	2	No
Exposed Lavatory Drains, Exposed Domestic Water Piping & Drains to Areas for Handicapped Personnel					
	Flexible Elastomeric Cellular	ASTM C534/C534M	I		No
Condensate Drain Located Inside Building					
	Cellular Glass	ASTM C552	II	2	No
	Flexible Elastomeric Cellular	ASTM C534/C534M	I		No
Medium Temperature Hot Water, Steam and Condensate (251 to 350 Degrees F)					
	Mineral Fiber	ASTM C547	I	1	No
	Calcium Silicate	ASTM C533	I		No

TABLE 1					
Insulation Material for Piping					
Service					
	Material	Specification	Type	Class	VR/VB Req'd
	Cellular Glass	ASTM C552	I or II		No
	Perlite	ASTM C610			No
	Flexible Elastomeric Cellular	ASTM C534/C534M	I	2	No
High Temperature Hot Water & Steam (351 to 700 Degrees F)					
	Mineral Fiber	ASTM C547	I	2	No
	Calcium Silicate	ASTM C533	I		No
	Perlite	ASTM C610			No
	Cellular Glass	ASTM C552			No
Note: VR/VB = Vapor Retarder/Vapor Barrier					

TABLE 2						
Piping Insulation Thickness (inch) Do not use integral wicking material in Chilled water applications exposed to outdoor ambient conditions in climatic zones 1 through 4.						
Service						
	Material	Tube And Pipe Size (inch)				
		<1	1-<1.5	1.5-<4	4-<8	> or = >8
Chilled Water (Supply & Return, Dual Temperature Piping, 40 Degrees F nominal)						
	Cellular Glass	1.5	2	2	2.5	3
	Flexible Elastomeric Cellular	1				
Chilled Water (Supply & Return, Dual Temperature Piping, 40 Degrees F nominal)						
	Cellular Glass	1.5	1.5	1.5	1.5	2

TABLE 2						
Piping Insulation Thickness (inch) Do not use integral wicking material in Chilled water applications exposed to outdoor ambient conditions in climatic zones 1 through 4.						
Service						
	Material	Tube And Pipe Size (inch)				
		<1	1-<1.5	1.5-<4	4-<8	> or = >8
	Flexible Elastomeric Cellular	1				
	Mineral Fiber with Wicking Material	1				
Heating Hot Water Supply & Return, Heated Oil (Max 250 F)						
	Mineral Fiber	1.5	1.5	2	2	2
Cold Domestic Water Piping, Makeup Water & Drinking Fountain Drain Piping						
	Cellular Glass	1.5	1.5	1.5	1.5	1.5
	Flexible Elastomeric Cellular	1				
Hot Domestic Water Supply & Recirculating Piping (Max 200 F)						
	Mineral Fiber	1	1	1	1.5	1.5
Refrigerant Suction Piping (35 degrees F nominal)						
	Flexible Elastomeric Cellular	1	1	1	N/A	N/A
	Cellular Glass	1.5	1.5	1.5	1.5	1.5
Compressed Air Discharge, Steam and Condensate Return (201 to 250 Degrees F)						
Exposed Lavatory Drains, Exposed Domestic Water Piping & Drains to Areas for Handicapped Personnel						
	Flexible Elastomeric Cellular	0.5	0.5	0.5	0.5	0.5
Condensate Drain Located Inside Building						
	Cellular Glass	1.5	1.5	1.5	1.5	1.5
	Flexible Elastomeric Cellular	1	1	1	N/A	N/A
Medium Temperature Hot Water, Steam and Condensate (251 to 350 Degrees F)						

TABLE 2						
Piping Insulation Thickness (inch) Do not use integral wicking material in Chilled water applications exposed to outdoor ambient conditions in climatic zones 1 through 4.						
Service						
	Material	Tube And Pipe Size (inch)				
		<1	1-<1.5	1.5-<4	4-<8	> or = >8
	Mineral Fiber	1.5	3	3	4	4
		2.5*	*	3.5*		

3.2.2 Aboveground Cold Pipelines

Insulate the following cold pipelines for minus 30 to plus 60 degrees F in accordance with Table 2 except those piping listed in subparagraph Pipe Insulation in PART 3 as to be omitted. This includes but is not limited to the following:

- Make-up water.
- Horizontal and vertical portions of interior roof drains.
- Refrigerant suction lines.
- Chilled water.
- Dual temperature water, i.e. HVAC hot/chilled water.
- Air conditioner condensate drains.
- Exposed lavatory drains and domestic water lines serving plumbing fixtures for handicap persons.
- Domestic cold and chilled drinking water.

3.2.2.1 Insulation Material and Thickness

Determine insulation thickness for cold pipelines using Table 2.

3.2.2.2 Factory or Field applied Jacket

Cover insulation with a factory applied vapor retarder jacket/vapor barrier or field applied seal welded PVC jacket or greater than 3 ply laminated self-adhesive (minimum 2 mils adhesive, 3 mils embossed) vapor barrier/weatherproofing jacket - less than 0.0000 permeability, standard grade, sliver, white, black and embossed for use with Mineral Fiber, Cellular Glass, and Phenolic Foam Insulated Pipe. For insulation inside

the building, to be protected with an aluminum jacket or greater than 3 ply vapor barrier/weatherproofing self-adhesive (minimum 2 mils adhesive, 3 mils embossed) product, less than 0.0000 permeability, standard grade, Embossed Silver, White & Black, install the insulation and vapor retarder jacket as specified herein. Install the aluminum jacket or greater than 3 ply vapor barrier/weatherproofing self-adhesive (minimum 2 mils adhesive, 3 mils embossed) product, less than 0.0000 permeability, standard grade, embossed silver, White & Black, as specified for piping exposed to weather, except sealing of the laps of the aluminum jacket is not required. In high abuse areas such as janitor closets and traffic areas in equipment rooms, kitchens, and mechanical rooms, provide aluminum jackets or greater than 3 ply vapor barrier/weatherproofing self-adhesive (minimum 2 mils adhesive, 3 mils embossed) product, less than 0.0000 permeability, standard grade, embossed silver, white & black, for pipe insulation to the 6 ft level.

3.2.2.3 Installing Insulation for Straight Runs Hot and Cold Pipe

Apply insulation to the pipe with tight butt joints. Seal all butted joints and ends with joint sealant and seal with a vapor retarder coating, greater than 3 ply laminate jacket - less than 0.0000 perm adhesive tape or PVDC adhesive tape.

3.2.2.3.1 Longitudinal Laps of the Jacket Material

Overlap not less than 1-1/2 inches. Provide butt strips 3 inches wide for circumferential joints.

3.2.2.3.2 Laps and Butt Strips

Secure with adhesive and staple on 4 inch centers if not factory self-sealing. If staples are used, seal in accordance with paragraph STAPLES below. Note that staples are not required with cellular glass systems.

3.2.2.3.3 Factory Self-Sealing Lap Systems

May be used when the ambient temperature is between 40 and 120 degrees F during installation. Install the lap system in accordance with manufacturer's recommendations. Use a stapler only if specifically recommended by the manufacturer. Where gaps occur, replace the section or repair the gap by applying adhesive under the lap and then stapling.

3.2.2.3.4 Staples

Coat all staples, including those used to repair factory self-seal lap systems, with a vapor retarder coating or PVDC adhesive tape or greater than 3 ply laminate jacket - 0.0000 perm adhesive tape. Coat all seams, except those on factory self-seal systems, with vapor retarder coating or PVDC adhesive tape or greater than 3 ply laminate jacket - less than 0.0000 perm adhesive tape.

3.2.2.3.5 Breaks and Punctures in the Jacket Material

Patch by wrapping a strip of jacket material around the pipe and secure it with adhesive, staple, and coat with vapor retarder coating or PVDC adhesive tape or greater than 3 ply laminate jacket - less than 0.0000 perm adhesive tape. Extend the patch not less than 1-1/2 inches past the break.

3.2.2.3.6 Penetrations Such as Thermometers

Fill the voids in the insulation and seal with vapor retarder coating or PVDC adhesive tape or greater than 3 ply laminate jacket - less than 0.0000 perm adhesive tape.

3.2.2.3.7 Flexible Elastomeric Cellular Pipe Insulation

Install by slitting the tubular sections and applying them onto the piping or tubing. Alternately, whenever possible slide un-slit sections over the open ends of piping or tubing. Secure all seams and butt joints and seal with adhesive. When using self seal products, secure only the butt joints with adhesive. Push insulation on the pipe, never pulled. Stretching of insulation may result in open seams and joints. Clean cut all edges. Rough or jagged edges of the insulation are not be permitted. Use proper tools such as sharp knives. Do not stretch Grade 1, Type II sheet insulation around the pipe when used on pipe larger than 6 inches. On pipes larger than 12 inches, adhere sheet insulation directly to the pipe on the lower 1/3 of the pipe.

3.2.2.4 Insulation for Fittings and Accessories

- a. Butt pipe insulation tightly to the insulation of the fittings and accessories. Seal the butted joints and ends with joint sealant and seal with a vapor retarder coating or PVDC adhesive tape or greater than 3 ply laminate jacket - less than 0.0000 perm adhesive tape.
- b. Place precut or preformed insulation around all fittings and accessories and conform to MICA plates except as modified herein: 5 for anchors; 10, 11, and 13 for fittings; 14 for valves; and 17 for flanges and unions. Insulation must be the same insulation as the pipe insulation, including same density, thickness, and thermal conductivity. Where precut/preformed is unavailable, rigid preformed pipe insulation sections may be segmented into the shape required. Use insulation of the same thickness and conductivity as the adjoining pipe insulation. If nesting size insulation is used, overlap the insulation 2 inches or one pipe diameter. Elbows insulated using segments must conform to MICA Tables 12.20 "Mitered Insulation Elbow". Submit a booklet containing completed MICA Insulation Stds plates detailing each insulating system for each pipe, duct, or equipment insulating system, after approval of materials and prior to applying insulation.
 - (1) Ensure MICA plates detail the materials to be installed and the specific insulation application. Submit all MICA plates required showing the entire insulating system, including plates required to show insulation penetrations, vessel bottom and top heads, legs, and skirt insulation as applicable. Present all variations of insulation systems including locations, materials, vaporproofing, jackets and insulation accessories.
 - (2) If the Contractor elects to submit detailed drawings instead of edited MICA Plates, ensure the detail drawings are technically equivalent to the edited MICA Plate submittal.
- c. Upon completion of insulation installation on flanges, unions, valves, anchors, fittings and accessories, terminations, seams, joints and insulation not protected by factory vapor retarder jackets or PVC

fitting covers must be protected with PVDC or greater than 3 ply laminate jacket - less than 0.0000 perm adhesive tape or two coats of vapor retarder coating with a minimum total thickness of 1/16 inch, applied with glass tape embedded between coats. Overlap tap seams 1 inch. Extend the coating out onto the adjoining pipe insulation 2 inches. Protect fabricated insulation with a factory vapor retarder jacket with either greater than 3 ply laminate jacket - less than 0.0000 perm adhesive tape, standard grade, silver, white, black and embossed or PVDC adhesive tape or two coats of vapor retarder coating with a minimum thickness of 1/16 inch and with a 2 inch wide glass tape embedded between coats. Where fitting insulation butts to pipe insulation, seal the joints with a vapor retarder coating and a 4 inch wide ASJ tape which matches the jacket of the pipe insulation.

- d. Insulate anchors attached directly to the pipe for a sufficient distance to prevent condensation but no less than 6 inches from the insulation surface.
- e. Mark insulation to show the location of unions, strainers, and check valves.

3.2.2.5 Optional PVC Fitting Covers

At the option of the Contractor, premolded, one or two piece PVC fitting covers may be used in lieu of the vapor retarder and embedded glass tape. Use factory precut or premolded insulation segments under the fitting covers for elbows. Use insulation segments which are the same insulation as the pipe insulation including same density, thickness, and thermal conductivity. Secure the covers by PVC vapor retarder tape, adhesive, seal welding or with tacks made for securing PVC covers. Seal seams in the cover, and tacks and laps to adjoining pipe insulation jacket, with vapor retarder tape to ensure that the assembly has a continuous vapor seal.

3.2.3 Aboveground Hot Pipelines

3.2.3.1 General Requirements

Insulate all hot pipe lines above 60 degrees F, except those piping listed in subparagraph Pipe Insulation in PART 3 as to be omitted, in accordance with Table 2. This includes but is not limited to the following:

- a. Domestic hot water supply & re-circulating system.
- b. Steam.
- c. Condensate & compressed air discharge.
- d. Hot water heating.
- e. Heated oil.
- f. Water defrost lines in refrigerated rooms.

Cover insulation, in accordance with manufacturer's recommendations, with a factory applied Type I jacket or field applied aluminum where required or seal welded PVC.

3.2.3.2 Insulation for Fittings and Accessories

Butt pipe insulation tightly to the insulation of the fittings and accessories. Seal butted joints and ends with joint sealant. Mark insulation to show the location of unions, strainers, check valves and other components that would otherwise be hidden from view by the insulation.

3.2.3.2.1 Precut or Preformed

Place precut or preformed insulation around all fittings and accessories. Use the same insulation as the pipe insulation, including same density, thickness, and thermal conductivity.

3.2.3.2.2 Rigid Preformed

Where precut/preformed is unavailable, rigid preformed pipe insulation sections may be segmented into the shape required. Use insulation that is the same thickness and conductivity as the adjoining pipe insulation. If nesting size insulation is used, do not overlap insulation 2 inches or one pipe diameter. Elbows insulated using segments must conform to MICA Tables 12.20 "Mitered Insulation Elbow".

3.2.4 Piping Exposed to Weather

Insulate and jacket piping exposed to weather as specified for the applicable service inside the building. After this procedure, apply a laminated self-adhesive (minimum 2 mils adhesive, 3 mils embossed) vapor barrier/weatherproofing jacket - less than 0.0000 permeability (greater than 3 ply, standard grade, silver, white, black and embossed aluminum jacket, stainless steel or PVC jacket).

PVC jacketing requires no factory-applied jacket beneath it, however apply an all service jacket if factory applied jacketing is not furnished. Treat flexible elastomeric cellular insulation exposed to weather in accordance with paragraph INSTALLATION OF FLEXIBLE ELASTOMERIC CELLULAR INSULATION in PART 3.

3.2.4.1 Aluminum Jacket

The jacket for hot piping may be factory applied. Overlap the jacket no less than 2 inches at longitudinal and circumferential joints and secure with bands at no more than 12 inch centers. Overlap longitudinal joints down to shed water and locate at 4 or 8 o'clock positions. Seal joints on piping 60 degrees F and below with metal jacketing/flashing sealant while overlapping to prevent moisture penetration. Where jacketing on piping 60 degrees F and below abuts an un-insulated surface, caulk joints to prevent moisture penetration. Seal joints on piping above 60 degrees F with a moisture retarder.

3.2.4.2 Insulation for Fittings

Insulate and finish flanges, unions, valves, fittings, and accessories as specified for the applicable service. Apply two coats of breather emulsion type weatherproof mastic (impermeable to water, permeable to air) recommended by the insulation manufacturer with glass tape embedded between coats. Overlap tap no less than 1 inch and the adjoining aluminum jacket no less than 2 inches. Factory preformed aluminum jackets may be used in lieu of the above. Provide molded PVC fitting covers when PVC

jackets are used for straight runs of pipe. Provide PVC fitting covers that have adhesive welded joints and are weatherproof laminated self-adhesive (minimum 2 mils adhesive, 3 mils embossed) vapor barrier/weatherproofing jacket - less than 0.0000 permeability, (greater than 3 ply, standard grade, silver, white, black and embossed, and UV resistant).

3.2.4.3 PVC Jacket

Provide ultraviolet resistant PVC jacket that is adhesive welded weather tight with manufacturer's recommended adhesive. Include provision for thermal expansion.

3.2.4.4 Stainless Steel Jackets

ASTM A167 or ASTM A240/A240M; Type 304, minimum thickness of 33 gauge (0.010 inch), smooth surface with factory-applied polyethylene and kraft paper moisture barrier on inside surface. Provide stainless steel bands, minimum width of 1/2 inch.

3.3 DUCT INSULATION SYSTEMS INSTALLATION

Except for oven hood exhaust duct insulation, install corner angles on external corners of insulation on ductwork in exposed finished spaces before covering with jacket. Omit duct insulation on exposed supply and return ducts in air conditioned spaces. Air conditioned spaces are defined as those spaces directly supplied with cooled conditioned air (or provided with a cooling device such as a fan-coil unit) and heated conditioned air (or provided with a heating device such as a unit heater, radiator or convector).

3.3.1 Duct Insulation Minimum Thickness

Duct insulation minimum thickness in accordance with Table 4.

Table 4 - Minimum Duct Insulation (inches)	
Cold Air Ducts	2.0
Relief Ducts	1.5
Fresh Air Intake Ducts	1.5
Warm Air Ducts	2.0
Relief Ducts	1.5
Fresh Air Intake Ducts	1.5

3.3.2 Insulation and Vapor Retarder/Vapor Barrier for Cold Air Duct

Provide insulation and vapor retarder/vapor barrier for the following cold air ducts and associated equipment.

- a. Supply ducts.

- b. Return air ducts.
- c. Relief ducts.
- d. Flexible run-outs (field-insulated).
- e. Plenums.
- f. Duct-mounted coil casings.
- g. Coil headers and return bends.
- h. Coil casings.
- i. Fresh air intake ducts.
- j. Filter boxes.
- k. Mixing boxes (field-insulated).
- l. Supply fans (field-insulated).
- m. Site-erected air conditioner casings.
- n. Ducts exposed to weather.
- o. Combustion air intake ducts.

Use insulation for rectangular ducts that is flexible type where concealed, minimum density $3/4$ pcf, and rigid type where exposed, minimum density 3 pcf. Provide insulation for both concealed or exposed round/oval ducts that is flexible type, minimum density $3/4$ pcf or a semi rigid board, minimum density 3 pcf, formed or fabricated to a tight fit, edges beveled and joints tightly butted and staggered. Provide insulation for all exposed ducts with either a white, paint-able, factory-applied Type I jacket or a field applied vapor retarder/vapor barrier jacket coating finish as specified. Ensure the total field applied dry film thickness is approximately $1/16$ inch. Provide insulation on all concealed duct with a factory-applied Type I or II vapor retarder/vapor barrier jacket. Continue duct insulation through sleeves and prepare openings except firewall penetrations. Duct insulation terminating at fire dampers, must be continuous over the damper collar and retaining angle of fire dampers, which are exposed to unconditioned air and which may be prone to condensate formation. Provide duct insulation and vapor retarder/vapor barrier to cover the collar, neck, and un-insulated surfaces of diffusers, registers and grills. Apply vapor retarder/vapor barrier materials to form a complete unbroken vapor seal over the insulation. Seal sheet metal duct in accordance with Section 23 30 00 HVAC AIR DISTRIBUTION.

3.3.2.1 Installation on Concealed Duct

- a. For rectangular, oval or round ducts, attach flexible insulation by applying adhesive around the entire perimeter of the duct in 6 inch wide strips on 12 inch centers.
- b. For rectangular and oval ducts, 24 inches and larger, additionally secure insulation to bottom of ducts using mechanical fasteners. Space fasteners on 16 inch centers and no more than 16 inches from

duct corners.

- c. For rectangular, oval and round ducts, provide mechanical fasteners on sides of duct risers for all duct sizes. Space fasteners on 16 inch centers and no more than 16 inches from duct corners.
- d. Impale insulation on the mechanical fasteners (self stick pins) where used and press thoroughly into the adhesive. Take care to ensure vapor retarder/vapor barrier jacket joints overlap 2 inches. Do not compress insulation to a thickness less than that specified. Carry insulation over standing seams and trapeze-type duct hangers.
- e. Where mechanical fasteners are used, install self-locking washers and trim and bend the pin over.
- f. Secure jacket overlaps with staples and tape as necessary to ensure a secure seal. Coat staples, tape and seams with a brush coat of vapor retarder coating or PVDC adhesive tape or greater than 3 ply laminate (minimum 2 mils adhesive, 3 mils embossed) - less than 0.0000 perm adhesive tape.
- g. Cover breaks in the jacket material with patches of the same material as the vapor retarder jacket. Do not extend patches less than 2 inches beyond the break or penetration in all directions and secure with tape and staples. Seal staples and tape joints with a brush coat of vapor retarder coating or PVDC adhesive tape or greater than 3 ply laminate (minimum 2 mils adhesive, 3 mils embossed) - less than 0.0000 perm adhesive tape.
- h. At jacket penetrations such as hangers, thermometers, and damper operating rods, fill voids in the insulation and seal the penetration with a brush coat of vapor retarder coating or PVDC adhesive tape greater than 3 ply laminate (minimum 2 mils adhesive, 3 mils embossed) - less than 0.0000 perm adhesive tape.
- i. Seal insulation terminations and pin punctures and flash with a reinforced vapor retarder coating finish or tape with a brush coat of vapor retarder coating.. Ensure the coating overlaps the adjoining insulation and un-insulated surface 2 inches. Extend pin puncture coatings 2 inches from the puncture in all directions.
- j. Where insulation standoff brackets occur, extend insulation under the bracket and terminate the jacket at the bracket.

3.3.2.2 Installation on Exposed Duct Work

- a. For rectangular ducts, secure rigid insulation to the duct by mechanical fasteners on all four sides of the duct, space no more than 12 inches apart and no more than 3 inches from the edges of the insulation joints. Provide a minimum of two rows of fasteners for each side of duct 12 inches and larger. Provide one row for each side of duct less than 12 inches. Provide mechanical fasteners that are corrosion resistant as G60 coated galvanized steel, and indefinitely sustain a 50 lb tensile dead load test perpendicular to the duct wall.
- b. Form duct insulation with minimum jacket seams. Fasten each piece of rigid insulation to the duct using mechanical fasteners. When the height of projections is less than the insulation thickness, bring insulation up to standing seams, reinforcing, and other vertical

projections and do not carry over. Continue vapor retarder/barrier jacket across seams, reinforcing, and projections. When height of projections is greater than the insulation thickness, carry over insulation and jacket. Apply insulation with joints tightly butted. Neatly bevel insulation around name plates and access plates and doors.

- c. Impale insulation on the fasteners; install self-locking washers and trim and bend the pin over.
- d. Seal joints in the insulation jacket with a 4 inch wide strip of tape. Seal taped seams with a brush coat of vapor retarder coating.
- e. Cover breaks and ribs or standing seam penetrations in the jacket material with a patch of the same material as the jacket. Do not extend patches less than 2 inches beyond the break or penetration and secure with tape and staple. Seal staples and joints with a brush coat of vapor retarder coating.
- f. At jacket penetrations such as hangers, thermometers, and damper operating rods, fill the voids in the insulation and seal the penetrations with a flashing sealant.
- g. Seal and flash insulation terminations and pin punctures with a reinforced vapor retarder coating finish. Ensure coating overlaps the adjoining insulation and un-insulated surface 2 inches. Extend pin puncture coatings 2 inches from the puncture in all directions.
- h. Insulate oval and round ducts, flexible type, with factory Type I jacket insulation with minimum density of 3/4 pcf, attach in accordance with MICA standards.

3.3.3 Insulation for Warm Air Duct

Provide insulation and vapor barrier for the following warm air ducts and associated equipment:.

- a. Supply ducts.
- b. Return air ducts.
- c. Relief air ducts
- d. Flexible run-outs (field insulated).
- e. Plenums.
- f. Duct-mounted coil casings.
- g. Coil-headers and return bends.
- h. Coil casings.
- i. Fresh air intake ducts.
- j. Filter boxes.
- k. Mixing boxes.
- l. Supply fans.

- m. Site-erected air conditioner casings.
- n. Ducts exposed to weather.
- o. Exhaust ducts passing through concealed spaces exhausting conditioned air.

Provide insulation for rectangular ducts that is flexible type where concealed, and rigid type where exposed. Provide insulation on exposed ducts with a white, paint-able, factory-applied Type II jacket, or finish with adhesive finish. Use flexible type insulation for round ducts, with a factory-applied Type II jacket. Provide insulation on concealed duct with a factory-applied Type II jacket. Accomplish adhesive finish where indicated to be used by applying two coats of adhesive with a layer of glass cloth embedded between the coats. Ensure total dry film thickness is approximately **1/16 inch**. Continue duct insulation through sleeves and prepare openings. Terminate duct insulation at fire dampers and flexible connections.

3.3.3.1 Installation on Concealed Duct

- a. For rectangular, oval and round ducts, attach insulation by applying adhesive around the entire perimeter of the duct in **6 inch** wide strips on **12 inch** centers.
- b. For rectangular and oval ducts **24 inches** and larger, secure insulation to the bottom of ducts using mechanical fasteners. Space fasteners on **18 inch** centers and no more than **18 inches** from duct corner.
- c. For rectangular, oval and round ducts, provide mechanical fasteners on sides of duct risers for all duct sizes. Space fasteners on **18 inch** centers and no more than **18 inches** from duct corners.
- d. Impale insulation on the mechanical fasteners where used. Do not compress insulation to a thickness less than that specified. Carry insulation over standing seams and trapeze-type hangers.
- e. Install self-locking washers where mechanical fasteners are used and trim and bend the pin over.
- f. Do not overlap insulation jacket less than **2 inches** at joints and secure the lap and staple on **4 inch** centers.

3.3.3.2 Installation on Exposed Duct

- a. For rectangular ducts, secure the rigid insulation to the duct using mechanical fasteners on all four sides of the duct, space no more than **16 inches** apart and no more than **6 inches** from the edges of the insulation joints. Provide a minimum of two rows of fasteners for each side of duct **12 inches** and larger and a minimum of one row for each side of duct less than **12 inches**.
- b. Form duct insulation with factory-applied jacket with minimum jacket seams, and fasten each piece of rigid insulation to the duct using mechanical fasteners. When the height of projection is less than the insulation thickness, bring insulation up to standing seams, reinforcing, and other vertical projections and do not carry over the projection. Continue jacket across seams, reinforcing, and

projections. Where the height of projections is greater than the insulation thickness, carry insulation and jacket over the projection.

- c. Impale insulation on the fasteners; install self-locking washers and trim and bend the pin over.
- d. Seal joints on jacketed insulation with a 4 inch wide strip of tape and brush with vapor retarder coating.
- e. Cover breaks and penetrations in the jacket material with a patch of the same material as the jacket. Extend patches no less than 2 inches beyond the break or penetration and secure with adhesive and staple.
- f. Seal insulation terminations and pin punctures with tape and brush with vapor retarder coating.
- g. Insulate oval and round ducts, flexible type, with factory Type I jacket insulation, minimum density of 3/4 pcf attach by staples spaced no more than 16 inches and no more than 6 inches from the degrees of joints. Seal joints in accordance with item "d." above.

3.3.4 Ducts Handling Air for Dual Purpose

For air handling ducts for dual purpose below and above 60 degrees F, insulate ducts as specified for cold air duct.

3.3.5 Insulation for Evaporative Cooling Duct

Insulate evaporative cooling supply duct located in spaces not evaporatively cooled. Use material and installation requirements as specified for duct insulation for warm air duct.

3.3.6 Duct Test Holes

After duct systems have been tested, adjusted, and balanced, repair breaks in the insulation and jacket in accordance with the applicable section of this specification for the type of duct insulation to be repaired.

3.3.7 Duct Exposed to Weather

3.3.7.1 Installation

Insulate and finish ducts exposed to weather as specified for the applicable service for exposed duct inside the building. After the above is accomplished, further finish the insulation as detailed in the following subparagraphs.

3.3.7.2 Round Duct

Laminated self-adhesive (minimum 2 mils adhesive, 3 mils embossed) vapor barrier/weatherproofing jacket - Less than 0.0000 permeability, (greater than 3 ply, standard grade, silver, white, black and embossed or greater than 8 ply, heavy duty, white and natural) membrane must be applied overlapping material by 3 inches no bands or caulking needed - see manufacturer's recommended installation instructions. Aluminum jacket with factory applied moisture retarder must be applied with the joints lapped no less than 3 inches and secured with bands located at circumferential laps and at no more than 12 inch intervals throughout. Lap horizontal joints down to shed water and located at 4 or 8 o'clock

position. Seal joints with metal jacketing sealant to prevent moisture penetration. Where jacketing abuts an un-insulated surface, seal joints with metal jacketing sealant.

3.3.7.3 Fittings

Finish fittings and other irregular shapes as specified for rectangular ducts.

3.3.7.4 Rectangular Ducts

Apply two coats of weather barrier mastic reinforced with fabric or mesh for outdoor application to the entire surface. Ensure each coat of weatherproof mastic has a minimum thickness of **1/16 inch**. Ensure exterior is a metal jacketing applied for mechanical abuse and weather protection, and secure with screws or vapor barrier/weatherproofing jacket less than 0.0000 permeability greater than 3 ply, standard grade, silver, white, black, and embossed or greater than 8 ply, heavy duty white and natural. Apply membrane overlapping material by **3 inches**. No bands or caulking needed-see manufacturing recommend installation instructions.

3.3.8 Kitchen Exhaust Duct Insulation

NFPA 96 for ovens, griddles, deep fat fryers, steam kettles, vegetable steamers, high pressure cookers, and mobile serving units. Provide insulation with **3/4 inch** wide, minimum **0.15 inch** thick galvanized steel bands spaced not over **12 inches** o.c.; or 16 gauge galvanized steel wire with corner clips under the wire; or with heavy welded pins spaced not over **12 inches** apart each way. Do not use adhesives.

3.4 EQUIPMENT INSULATION SYSTEMS INSTALLATION

3.4.1 General

Provide removable insulation sections to cover parts of equipment that must be opened periodically for maintenance including vessel covers, fasteners, flanges and accessories. Omit equipment insulation on the following:

- a. Hand-holes.
- b. Boiler manholes.
- c. Cleanouts.
- d. ASME stamps.
- e. Manufacturer's nameplates.
- f. Duct Test/Balance Test Holes.

3.4.2 Insulation for Cold Equipment

Cold equipment below **60 degrees F**: Furnish insulation on equipment handling media below **60 degrees F** including the following:

- a. Pumps.
- b. Refrigeration equipment parts that are not factory insulated.

- c. Drip pans under chilled equipment.
- d. Cold water storage tanks.
- e. Water softeners.
- f. Duct mounted coils.
- g. Cold and chilled water pumps.
- h. Pneumatic water tanks.
- i. Air handling equipment parts that are not factory insulated.
- j. Expansion and air separation tanks.

3.4.2.1 Insulation Type

Provide insulation suitable for the temperature encountered. Provide material and thicknesses as shown in Table 5:

TABLE 5		
Insulation Thickness for Cold Equipment (inches)		
Equipment handling media at indicated temperature		
	Material	Thickness (inches)
35 to 60 degrees F		
	Cellular Glass	1.5
	Flexible Elastomeric Cellular	1
1 to 34 degrees F		
	Cellular Glass	3

3.4.2.2 Pump Insulation

- a. Insulate pumps by forming a box around the pump housing. Construct the box by forming the bottom and sides using joints that do not leave raw ends of insulation exposed. Join joints between sides and between sides and bottom by adhesive with lap strips for rigid mineral fiber and contact adhesive for flexible elastomeric cellular insulation. Ensure box conforms to the requirements of MICA Insulation Std's plate No. 49 when using flexible elastomeric cellular insulation. Ensure joints between top cover and sides fit tightly forming a female shiplap joint on the side pieces and a male joint on the top cover, thus making the top cover removable.
- b. Protect exposed insulation corners with corner angles.
- c. Upon completion of installation of the insulation, including removable sections, apply two coats of vapor retarder coating with a layer of

glass cloth embedded between the coats. The total dry thickness of the finish must be **1/16 inch**. Provide a parting line between the box and the removable sections allowing the removable sections to be removed without disturbing the insulation coating. Apply flashing sealant to parting line, between equipment and removable section insulation, and at all penetrations.

3.4.2.3 Other Equipment

- a. Form or fabricate insulation to fit the equipment. To ensure a tight fit on round equipment, bevel edges and tightly butt and stagger joints.
- b. Secure insulation in place with bands or wires at intervals as recommended by the manufacturer but no more than **12 inch** centers except adhere flexible elastomeric cellular with contact adhesive. Protect insulation corners under wires and bands with suitable corner angles.
- c. Install cellular glass in accordance with manufacturer's instructions. Seal joints and ends with joint sealant, and seal with a vapor retarder coating.
- d. Use removable insulation on heads of heat exchangers. Fabricate removable section joints using a male-female shiplap type joint. Finish the entire surface of the removable section by applying two coats of vapor retarder coating with a layer of glass cloth embedded between the coats. The total dry thickness of the finish must be **1/16 inch**.
- e. Protect exposed insulation corners with corner angles.
- f. Apply insulation on equipment with ribs over **6 by 6 inches** by 12 gauge welded wire fabric which has been cinched in place, or if approved by the Contracting Officer, spot weld to the equipment over the ribs. Secure insulation to the fabric with J-hooks and **2 by 2 inches** washers or securely band or wire in place on **12 inch** centers.

3.4.2.4 Vapor Retarder/Vapor Barrier

Upon completion of installation of insulation, caulk penetrations. Apply two coats of vapor retarder coating or vapor barrier jacket over insulation, including removable sections, with a layer of open mesh synthetic fabric embedded between the coats. Ensure the total dry thickness of the finish is **1/16 inch**. Apply flashing sealant or vapor barrier tape to parting line between equipment and removable section insulation.

3.4.3 Insulation for Hot Equipment

Furnish insulation on equipment handling media above **60 degrees F** including the following:

- a. Converters.
- b. Heat exchangers.
- c. Hot water generators.

- d. Water heaters.
- e. Pumps handling media above 130 degrees F.
- f. Hot water storage tanks.
- g. Air separation tanks.
- h. Surge tanks.
- i. Flash tanks.
- j. Feed-water heaters.
- k. Unjacketed boilers or parts of boilers.
- l. Boiler flue gas connection from boiler to stack (if inside).
- m. Induced draft fans.
- n. Fly ash and soot collectors.
- o. Condensate receivers.

3.4.3.1 Insulation

Provide insulation suitable for the temperature encountered. Insulate shell and tube-type heat exchangers for the temperature of the shell medium.

Determine insulation thickness for hot equipment using Table 6:

TABLE 6		
Insulation Thickness for Hot Equipment (inches)		
Equipment handling steam or media at indicated pressure or temperature limit		
	Material	Thickness (inches)
15 psig or 250 degrees F		
	Rigid Mineral Fiber	2
	Flexible Mineral Fiber	2
	Flexible Elastomeric Cellular (<200 F)	1
600 degrees F: Thickness necessary to limit the external temperature of the insulation to 120 F. Submit heat transfer calculations to substantiate insulation and thickness selection.		

3.4.3.2 Insulation of Boiler Stack and Diesel Engine Exhaust Pipe

Inside mechanical Room, bevel insulation neatly around openings and

provide sheet metal insulation stop strips around such openings. Apply a skim coat of hydraulic setting cement directly to insulation. Apply a flooding coat of adhesive over hydraulic setting cement, and while still wet, press a layer of glass cloth or tape into adhesive and seal laps and edges with adhesive. Coat glass cloth with adhesive. When dry, apply a finish coat of adhesive at can-consistency so that when dry no glass weave is observed. Provide metal jackets for exhaust pipes that are located above finished floor and spaces outside mechanical room. Apply metal jackets directly over insulation and secure with 3/4 inch wide metal bands spaced on 18 inch centers. Do not insulate name plates. Provide insulation type and thickness in accordance with the following Table 7.

TABLE 7						
Insulation and Thickness for Boiler Stack Exhaust Pipe						
Service & Surface Temperature Range (Degrees F)						
	Material	Outside Diameter (Inches)				
		0.25 - 1.25	1 - 1.67	3.5-5	6 - 10	> or = 11 - 36
Boiler Stack (Up to 400 degrees F)						
	Mineral Fiber ASTM C585 Class B-3, ASTM C547 Class 1, or ASTM C612 Class 1	N/A	N/A	3	3.5	4
	Calcium Silicate ASTM C533, Type 1	N/A	N/A	3	3.5	4
	Cellular Glass ASTM C552, Type II	1.5	1.5	1.5	2	2.5
Boiler Stack (401 to 600 degrees F)						
	Mineral Fiber ASTM C547 Class 2, ASTM C592 Class 1, or ASTM C612 Class 3	N/A	N/A	4	4	5
	Calcium Silicate ASTM C533, Type I or II	N/A	N/A	4	4	4
	Mineral Fiber/Cellular Glass Composite:					

TABLE 7						
Insulation and Thickness for Boiler Stack Exhaust Pipe						
Service & Surface Temperature Range (Degrees F)						
	Material	Outside Diameter (Inches)				
		0.25 - 1.25	1 - 1.67	3.5-5	6 - 10	> or = 11 - 36
	Mineral Fiber ASTM C547 Class 2, ASTM C592 Class 1, or ASTM C612 Class 3	1	1	1	1	2
	Cellular Glass ASTM C552, Type II	2	2	2	2	2
Boiler Stack (601 to 800 degrees F)						
	Mineral Fiber ASTM C547 Class 3, ASTM C592 Class 1, or ASTM C612 Class 3	N/A	N/A	4	4	6
	Calcium Silicate ASTM C533, Type I or II	N/A	N/A	4	4	6
	Mineral Fiber/Cellular Glass Composite:					
	Mineral Fiber ASTM C547 Class 2, ASTM C592 Class 1, or ASTM C612 Class 3	2	2	2	3	3
	Cellular Glass ASTM C552, Type II	2	2	2	2	2

3.4.3.3 Insulation of Pumps

Insulate pumps by forming a box around the pump housing. Construct the box by forming the bottom and sides using joints that do not leave raw ends of insulation exposed. Band bottom and sides to form a rigid housing that does not rest on the pump. Ensure joints between top cover and sides fit tightly. The top cover must have a joint forming a female shiplap joint on the side pieces and a male joint on the top cover, making the top cover removable. Apply two coats of Class I adhesive over insulation,

including removable sections, with a layer of glass cloth embedded between the coats. Provide a parting line between the box and the removable sections allowing the removable sections to be removed without disturbing the insulation coating. The total dry thickness of the finish must be $\frac{1}{16}$ inch. Apply caulking to parting line of the removable sections and penetrations.

3.4.3.4 Other Equipment

- a. Form or fabricate insulation to fit the equipment. To ensure a tight fit on round equipment, bevel edges and tightly butt and stagger joints.
- b. Secure insulation in place with bands or wires at intervals as recommended by the manufacturer but no greater than 12 inch centers except adhere flexible elastomeric cellular. Protect insulation corners under wires and bands with suitable corner angles.
- c. On high vibration equipment, set cellular glass insulation in a coating of bedding compound as recommended by the manufacturer, and seal joints with bedding compound. Fill mineral fiber joints with finishing cement.
- d. Provide removable insulation on heads of heat exchangers. Fabricate the removable section joint using a male-female shiplap type joint. Finish the entire surface of the removable section as specified.
- e. Protect exposed insulation corners with corner angles.
- f. On equipment with ribs, such as boiler flue gas connection, draft fans, and fly ash or soot collectors, apply insulation over 6 by 6 inch by 12 gauge welded wire fabric which has been cinched in place, or if approved by the Contracting Officer, spot weld to the equipment over the ribs. Secure insulation to the fabric with J-hooks and 2 by 2 inch washers or securely band or wire in place on 12 inch (maximum) centers.
- g. On equipment handling media above 600 degrees F, apply insulation in two or more layers with staggered joints.
- h. Upon completion of installation of insulation, caulk penetrations. Apply two coats of adhesive over insulation, including removable sections, with a layer of glass cloth embedded between the coats. The total dry thickness of the finish must be $\frac{1}{16}$ inch. Apply caulking to parting line between equipment and removable section insulation.

3.4.4 Equipment Exposed to Weather

3.4.4.1 Installation

Insulate equipment exposed to weather and finish in accordance with the requirements for ducts exposed to weather in paragraph DUCT INSULATION INSTALLATION.

3.4.4.2 Optional Panels

At the option of the Contractor, prefabricated metal insulation panels may be used in lieu of the insulation and finish previously specified. Thermal performance must be equal to or better than that specified for

field applied insulation. Provide panels that are the standard catalog product of a manufacturer of metal insulation panels. Provide fastenings, flashing, and support system conforming to published recommendations of the manufacturer for weatherproof installation and that prevent moisture from entering the insulation. Design panels to accommodate thermal expansion and to support a 250 pound walking load without permanent deformation or permanent damage to the insulation. Exterior metal cover sheet must be aluminum and exposed fastenings must be stainless steel or aluminum.

-- End of Section --

SECTION 23 09 00

INSTRUMENTATION AND CONTROL FOR HVAC
02/19, CHG 3: 05/21

PART 1 GENERAL

1.1 SUMMARY

Provide a complete Direct Digital Control (DDC) system, except for the Front End which is suitable for the control of the

heating, ventilating and air conditioning (HVAC) and other building-level systems as indicated and shown and in accordance with Section 23 09 13 INSTRUMENTATION AND CONTROL DEVICES FOR HVAC, Section 23 09 93 SEQUENCES OF OPERATION FOR HVAC CONTROL,

Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS for BACnet or Niagara BACnet systems, and other referenced Sections.

1.1.1 Proprietary Systems

1.1.1.1 Proprietary Systems Exempted From Open Protocol Requirements

The following systems are specifically exempted from the open protocol requirements of

Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS:

- a. A simple split (DX) system consisting of a single indoor unit and a single outdoor unit from the same manufacturer.
- b. Systems in Table I (previously approved by the designer in accordance with UFC 3-410-02).
- c. A system (not already shown Table I) of multiple boilers or multiple chillers communicating with a proprietary network for which an approved request has been obtained and for which: all units are from the same manufacturer, they are all co-located in the same room, the network connecting them is fully contained in that room, and the units are operating using a common "plant" sequence of operation which stages the units in a manner that requires operational parameters be shared between them and which cannot be accomplished with a single lead-lag command from a third-party controller.

1.1.1.2 Implementation of Proprietary Systems

For proprietary systems exempted from open protocol requirements, a proprietary network and DDC hardware communicating via proprietary protocol are permitted. For these systems a building control network meeting the requirements of

Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS must also be provided, along with a gateway or interface to connect the proprietary system to the open building control network.

The proprietary system gateway or interface must provide the required

functionality as shown on the points schedule. Scheduling, alarming, trending, overrides, network inputs, network outputs and other protocol related requirements must be met on the open protocol control system as specified in

Section 23 09 23.02 BACNET DIRECT
DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS.

1.1.1.3 Proprietary Multi-Split Engineering Tool Software

For each permitted proprietary systems in Table 1 shown as requiring Proprietary Multi-Split Engineering Tool Software, provide the software needed to replace a unit and configure the replacement. Submit hard copies of the software user manuals with the software submittal.

Submit Proprietary Multi-Split Engineering Tool Software on CD-ROM as a Technical Data Package. Submit 4 hard copies of the software user manual for each piece of software.

1.1.2 System Requirements

Provide systems meeting the requirements this Section and other Sections referenced by this Section, and which have the following characteristics:

- a. The system implements the control sequences of operation shown in the Contract Drawings using DDC hardware to control mechanical and electrical equipment
- b. The system meet the requirements of this specification as a stand-alone system and does not require connection to any other system.
- c. Control sequences reside in DDC hardware in the building. The building control network is not dependent upon connection to a Utility Monitoring and Control System (UMCS) Front End or to any other system for performance of control sequences. To the greatest extent practical, the hardware performs control sequences without reliance on the building network, unless otherwise pre-approved by the Contracting Officer.
- d. The hardware is installed such that individual control equipment can be replaced by similar control equipment from other equipment manufacturers with no loss of system functionality.
- e. All necessary documentation, configuration information, programming tools, programs, drivers, and other software are licensed to and otherwise remain with the Government such that the Government or their agents are able to perform repair, replacement, upgrades, and expansions of the system without subsequent or future dependence on the Contractor, Vendor or Manufacturer.
- f. Sufficient documentation and data, including rights to documentation and data, are provided such that the Government or their agents can execute work to perform repair, replacement, upgrades, and expansions of the system without subsequent or future dependence on the Contractor, Vendor or Manufacturer.
- g. Hardware is installed and configured such that the Government or their agents are able to perform repair, replacement, and upgrades of individual hardware without further interaction with the Contractor, Vendor or Manufacturer.

- h. All Niagara Framework components have an unrestricted interoperability license with a Niagara Compatibility Statement (NiCS) following the Tridium Open NiCS Specification and have a value of "ALL" for "Station Compatibility In", "Station Compatibility Out", "Tool Compatibility In" and "Tool Compatibility Out". Note that this will result in the following entries in the license file:
accept.station.in=""
accept.station.out=""
accept.wb.in=""
accept.wb.out=""

1.1.3 End to End Accuracy

Select products, install and configure the system such that the maximum error of a measured value as read from the DDC Hardware over the network is less than the maximum allowable error specified for the sensor or instrumentation.

1.1.4 Verification of Dimensions

After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing any work.

1.1.5 Drawings

The Government will not indicate all offsets, fittings, and accessories that may be required on the drawings. Carefully investigate the mechanical, electrical, and finish conditions that could affect the work to be performed, arrange such work accordingly, and provide all work necessary to meet such conditions.

1.2 RELATED SECTIONS

Related work specified elsewhere:

a.

Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS for BACnet systems with or without Niagara Framework.

b. Section 23 09 13 INSTRUMENTATION AND CONTROL DEVICES FOR HVAC

c. Section 23 09 93 SEQUENCES OF OPERATIONS FOR HVAC CONTROLS

1.3 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING
ENGINEERS (ASHRAE)

ASHRAE 135 (2020; Interpretation 1-8 2021; Errata 1-2 2021; Addenda CD 2021; Addenda BY-CE 2022; Interpretation 9-10 2022) BACnet—A Data Communication Protocol for Building Automation and Control Networks

ASHRAE FUN IP (2021) Fundamentals Handbook, I-P Edition

CONSUMER ELECTRONICS ASSOCIATION (CEA)

CEA-709.1-D (2014) Control Network Protocol Specification

CEA-709.3 (1999; R 2015) Free-Topology Twisted-Pair Channel Specification

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C62.41 (1991; R 1995) Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250 (2020) Enclosures for Electrical Equipment (1000 Volts Maximum)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (2023) National Electrical Code

NFPA 90A (2021) Standard for the Installation of Air Conditioning and Ventilating Systems

TRIDIUM, INC (TRIDIUM)

Niagara Framework (2012) NiagaraAX User's Guide

Tridium Open NiCS (2005) Understanding the NiagaraAX Compatibility Statement (NiCS)

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-410-02 (2018; with Change 2, 2021) Direct Digital Control for HVAC and Other Building Control Systems

UNDERWRITERS LABORATORIES (UL)

UL 5085-3 (2006; Reprint Jan 2022) UL Standard for

Safety Low Voltage Transformers - Part 3:
Class 2 and Class 3 Transformers

1.4 DEFINITIONS

The following list of definitions includes terms used in Sections referenced by this Section and are included here for completeness. The definitions contained in this Section may disagree with how terms are defined or used in other documents, including documents referenced by this Section. The definitions included here are the authoritative definitions for this Section and all Sections referenced by this Section.

After each term the protocol related to that term is included in parenthesis.

1.4.1 Alarm Generation (All protocols)

Alarm Generation is the monitoring of a value, comparison of the value to alarm conditions and the creation of an alarm when the conditions set for the alarm are met. Note that this does NOT include delivery of the alarm to the final destination (such as a user interface) - see paragraph ALARM ROUTING.

1.4.2 Application Generic Controller (AGC) (LonWorks)

A device that is furnished with a (limited) pre-established application that also has the capability of being programmed. Further, the ProgramID and XIF file of the device are fixed. The programming capability of an AGC may be less flexible than that of a General Purpose Programmable Controller (GPPC).

1.4.3 Application Specific Controller (ASC) (LonWorks)

A device that is furnished with a pre-established built in application that is configurable but not re-programmable. An ASC has a fixed factory-installed application program (i.e Program ID) with configurable settings.

1.4.4 Building Automation and Control Network (BACnet) (BACnet)

The term BACnet is used in two ways. First meaning the BACnet Protocol Standard - the communication requirements as defined by [ASHRAE 135](#) including all annexes and addenda. The second to refer to the overall technology related to the [ASHRAE 135](#) protocol.

1.4.5 BACnet Advanced Application Controller (B-AAC) (BACnet)

A hardware device BTL Listed as a B-AAC, which is required to support BACnet Interoperability Building Blocks (BIBBs) for scheduling and alarming, but is not required to support as many BIBBs as a B-BC.

1.4.6 BACnet Application Specific Controller (B-ASC) (BACnet)

A hardware device BTL Listed as a B-ASC, with fewer BIBB requirements than a B-AAC. It is intended for use in a specific application.

1.4.7 BACnet Building Controller (B-BC) (BACnet)

A hardware device BTL Listed as a B-BC. A general-purpose, field-programmable device capable of carrying out a variety of building automation and control tasks including control and monitoring via direct digital control (DDC) of specific systems and data storage for trend information, time schedules, and alarm data. Like the other BTL Listed controller types (B-AAC, B-ASC etc.) a B-BC device is required to support the server ("B") side of the ReadProperty and WriteProperty services, but unlike the other controller types it is also required to support the client ("A") side of these services. Communication between controllers requires that one of them support the client side and the other support the server side, so a B-BC is often used when communication between controllers is needed.

1.4.8 BACnet Broadcast Management Device (BBMD) (BACnet)

A communications device, typically combined with a BACnet router. A BBMD forwards BACnet broadcast messages to BACnet/IP devices and other BBMDs connected to the same BACnet/IP network. Each IP subnet that is part of a BACnet/IP network must have at least one BBMD. Note there are additional restrictions when multiple BBMDs share an IP subnet.

1.4.9 BACnet/IP (BACnet)

An extension of BACnet, Annex J, defines the use of a reserved UDP socket to transmit BACnet messages over IP networks. A BACnet/IP network is a collection of one or more IP subnets that share the same BACnet network number. See also paragraph BACNET BROADCAST MANAGEMENT DEVICE.

1.4.10 BACnet Internetwork (BACnet)

Two or more BACnet networks, connected with BACnet routers. In a BACnet Internetwork, there exists only one message path between devices.

1.4.11 BACnet Interoperability Building Blocks (BIBBs) (BACnet)

A BIBB is a collection of one or more **ASHRAE 135** Services intended to define a higher level of interoperability. BIBBs are combined to build the BACnet functional requirements for a device in a specification. Some BIBBs define additional requirements (beyond requiring support for specific services) in order to achieve a level of interoperability. For example, the BIBB DS-V-A (Data Sharing-View-A), which would typically be used by a front-end, not only requires the client to support the ReadProperty Service, but also provides a list of data types (Object / Properties) which the client must be able to interpret and display for the user.

In the BIBB shorthand notation, -A is the client side and -B is the server side.

The following is a list of some BIBBs used by this or referenced Sections:	
DS-COV-A	Data Sharing-Change of Value (A side)
DS-COV-B	Data Sharing-Change of Value (B side)

The following is a list of some BIBBs used by this or referenced Sections:	
NM-RC-B	Network Management-Router Configuration (B side)
DS-RP-A	Data Sharing-Read Property (A side)
DS-RP-B	Data Sharing-Read Property (B side)
DS-RPM-A	Data Sharing-Read Property Multiple (A Side)
DS-RPM-B	Data Sharing-Read Property Multiple (B Side)
DS-WP-A	Data Sharing-Write Property (A Side)
DM-TS-B	Device Management-Time Synchronization (B Side)
DM-UTC-B	Device Management-UTC Time Synchronization (B Side)
DS-WP-B	Data Sharing-Write Property (B side)
SCHED-E-B	Scheduling-External (B side)
DM-OCD-B	Device Management-Object Creation and Deletion (B side)
AE-N-I-B	Alarm and Event-Notification Internal (B Side)
AE-N-E-B	Alarm and Event-Notification External (B Side)
T-VMT-I-B	Trending-Viewing and Modifying Trends Internal (B Side)
T-VMT-E-B	Trending-Viewing and Modifying Trends External (B Side)

1.4.12 BACnet Network (BACnet)

In BACnet, a portion of the control Internetwork consisting of one or more segments connected by repeaters. Networks are separated by routers.

1.4.13 BACnet Operator Display (B-OD) (BACnet)

A basic operator interface with limited capabilities relative to a B-OWS. It is not intended to perform direct digital control. A B-OD profile could be used for LCD devices, displays affixed to BACnet devices, handheld terminals or other very simple user interfaces.

1.4.14 BACnet Segment (BACnet)

One or more physical segments interconnected by repeaters (ASHRAE 135).

1.4.15 BACnet Smart Actuator (B-SA) (BACnet)

A simple actuator device with limited resources intended for specific applications.

1.4.16 BACnet Smart Sensor (B-SS) (BACnet)

A simple sensing device with limited resources.

1.4.17 BACnet Testing Laboratories (BTL) (BACnet)

Established by BACnet International to support compliance testing and interoperability testing activities and consists of BTL Manager and the BTL Working Group (BTL-WG). BTL also publishes Implementation Guidelines.

1.4.18 BACnet Testing Laboratories (BTL) Listed (BACnet)

A device that has been listed by BACnet Testing Laboratory. Devices may be certified to a specific device profile, in which case the listing indicates that the device supports the required capabilities for that profile, or may be listed as "other".

1.4.19 Binary (All protocols)

A two-state system where an "ON" condition is represented by a high signal level and an "OFF" condition is represented by a low signal level. 'Digital' is sometimes used interchangeably with 'binary'.

1.4.20 Binding (LonWorks)

The act of establishing communications between CEA-709.1-D devices by associating the output of a device to the input of another so that information is automatically (and regularly) sent.

1.4.21 Broadcast (BACnet)

Unlike most messages, which are intended for a specific recipient device, a broadcast message is intended for all devices on the network.

1.4.22 Building Control Network (BCN) (All protocols)

The network connecting all DDC Hardware within a building (or specific group of buildings).

1.4.23 Building Point of Connection (BPOC) (All protocols)

A FPOC for a Building Control System. (This term is being phased out of use in preference for FPOC but is still used in some specifications and criteria. When it was used, it typically referred to a piece of control hardware. The current FPOC definition typically refers instead to IT hardware.)

1.4.24 Channel (LonWorks)

A portion of the control network consisting of one or more segments connected by repeaters. Channels are separated by routers. The device quantity limitation is dependent on the topology/media and device type. For example, a TP/FT-10 network with locally powered devices is limited to 128 devices per channel.

1.4.25 Commandable (All protocols)

See Overridable.

1.4.26 Commandable Objects (BACnet)

Commandable Objects have a Commandable Property, Priority_Array, and Relinquish_Default Property as defined in [ASHRAE 135](#), Clause 19.2, Command Prioritization.

1.4.27 Configurable (All protocols)

A property, setting, or value is configurable if it can be changed via hardware settings on the device, via the use of engineering software or over the control network from the front end, and is retained through (after) loss of power.

In a non-Niagara Framework BACnet system, a property, setting, or value is configurable if it can be changed via one or more of:

- 1) via BACnet services (including proprietary BACnet services)
- 2) via hardware settings on the device

In a Niagara Framework BACnet system, a property, setting, or value is configurable if it can be changed via one or more of:

- 1) via BACnet services (including proprietary BACnet services)
- 2) via hardware settings on the device
- 3) via the Niagara Framework

Note this is more stringent than the [ASHRAE 135](#) definition.

1.4.28 Configuration Property (LonWorks)

Controller parameter used by the application which is usually set during installation/testing and seldom changed. For example, the P and I settings of a P-I control loop. Also see paragraph STANDARD CONFIGURATION PROPERTY TYPE (SCPT).

1.4.29 Control Logic Diagram (All protocols)

A graphical representation of control logic for multiple processes that make up a system.

1.4.30 Device (BACnet)

A Digital Controller that contains a BACnet Device Object and uses BACnet to communicate with other devices.

1.4.31 Device Object (BACnet)

Every BACnet device requires one Device Object, whose properties represent the network visible properties of that device. Every Device Object requires a unique Object Identifier number on the BACnet Internetwork. This number is often referred to as the device instance or device ID.

1.4.32 Device Profile (BACnet)

A collection of BIBBs determining minimum BACnet capabilities of a device, defined in [ASHRAE 135](#). Standard device profiles include BACnet Advanced Workstations (B-AWS), BACnet Building Controllers (B-BC), BACnet Advanced Application Controllers (B-AAC), BACnet Application Specific Controllers (B-ASC), BACnet Smart Actuator (B-SA), and BACnet Smart Sensor (B-SS).

1.4.33 Digital Controller (All protocols)

An electronic controller, usually with internal programming logic and digital and analog input/output capability, which performs control functions.

1.4.34 Direct Digital Control (DDC) (All protocols)

Digital controllers performing control logic. Usually the controller directly senses physical values, makes control decisions with internal programs, and outputs control signals to directly operate switches, valves, dampers, and motor controllers.

1.4.35 Domain (LonWorks)

A grouping of up to 32,385 nodes that can communicate directly with each other. (Devices in different domains cannot communicate directly with each other.) See also Node Address.

1.4.36 Explicit Messaging (LonWorks)

A non-standard and often vendor (application) specific method of communication between devices where each message contains a message code that identifies the type of message and the devices use these codes to determine the action to take when the message is received.

1.4.37 External Interface File (XIF) (LonWorks)

A file which documents a device's external interface, specifically the number and types of LonMark objects, the number, types, directions, and connection attributes of network variables, and the number of message tags.

1.4.38 Field Point of Connection (FPOC) (All protocols)

The FPOC is the point of connection between the UMCS IP Network and the field control network (either an IP network, a non-IP network, or a combination of both). The hardware at this location which provides the connection is generally an IT device such as a switch, IP router, or firewall.

In general, the term "FPOC Location" means the place where this connection occurs, and "FPOC Hardware" means the device that provides the connection. Sometimes the term "FPOC" is used to mean either and its actual meaning (i.e. location or hardware) is determined by the context in which it is used.

1.4.39 Fox Protocol (Niagara Framework)

The protocol used for communication between components in the **Niagara Framework**. By default, Fox uses TCP port 1911.

1.4.40 Functional Profile (LonWorks)

A standard description, defined by LonMark, of one or more LonMark Objects used to classify and certify devices.

1.4.41 Gateway (All protocols)

A device that translates from one protocol application data format to

another. Devices that change only the transport mechanism of the protocol - "translating" from TP/FT-10 to Ethernet/IP or from BACnet MS/TP to BACnet over IP for example - are not gateways as the underlying data format does not change. Gateways are also called Communications Bridges or Protocol Translators.

A Niagara Framework Supervisory Gateway is one type of Gateway.

1.4.42 General Purpose Programmable Controller (GPPC) (LonWorks)

Unlike an ASC or AGC, a GPPC is not furnished with a fixed application program and does not have a fixed ProgramID or XIF file. A GPPC can be (re-)programmed, usually using vendor-supplied software. When a change to the program affects the external interface (and the XIF file) the ProgramID will change.

1.4.43 IEEE 802.3 Ethernet (All protocols)

A family of local-area-network technologies providing high-speed networking features over various media, typically Cat 5, 5e or Cat 6 twisted pair copper or fiber optic cable.

1.4.44 Internet Protocol (IP, TCP/IP, UDP/IP) (All protocols)

A communication method, the most common use is the World Wide Web. At the lowest level, it is based on Internet Protocol (IP), a method for conveying and routing packets of information over various LAN media. Two common protocols using IP are User Datagram Protocol (UDP) and Transmission Control Protocol (TCP). UDP conveys information to well-known "sockets" without confirmation of receipt. TCP establishes connections, also known as "sessions", which have end-to-end confirmation and guaranteed sequence of delivery.

1.4.45 Input/Output (I/O) (All protocols)

Physical inputs and outputs to and from a device, although the term sometimes describes network or "virtual" inputs or outputs. See also "Points".

1.4.46 I/O Expansion Unit (All protocols)

An I/O expansion unit provides additional point capacity to a digital controller

1.4.47 IP subnet (All protocols)

A group of devices which share a defined range IP addresses. Devices on a common IP subnet can share data (including broadcasts) directly without the need for the traffic to traverse an IP router.

1.4.48 JACE (Niagara Framework)

Java Application Control Engine. See paragraph NIAGARA FRAMEWORK SUPERVISORY GATEWAY

1.4.49 Local-Area Network (LAN) (All protocols)

A communication network that spans a limited geographic area and uses the same basic communication technology throughout.

1.4.50 Local Display Panels (LDPs) (All protocols)

A DDC Hardware with a display and navigation buttons, and must provide display and adjustment of points as shown on the Points Schedule and as indicated.

1.4.51 LonMark (LonWorks)

See paragraph LONMARK INTERNATIONAL. Also, a certification issued by LonMark International to CEA-709.1-D devices.

1.4.52 LonMark International (LonWorks)

Standards committee consisting of numerous independent product developers, system integrators and end users dedicated to determining and maintaining the interoperability guidelines for LonWorks. Maintains guidelines for the interoperability of CEA-709.1-D devices and issues the LonMark Certification for CEA-709.1-D devices.

1.4.53 LonMark Interoperability Association (LonWorks)

See paragraph LONMARK INTERNATIONAL.

1.4.54 LonMark Object (LonWorks)

A collection of network variables, configuration properties, and associated behavior defined by LonMark International and described by a Functional Profile. It defines how information is exchanged between devices on a network (inputs from and outputs to the network).

1.4.55 LonWorks (LonWorks)

The term used to refer to the overall technology related to the CEA-709.1-D protocol (sometimes called "LonTalk"), including the protocol itself, network management, interoperability guidelines and products.

1.4.56 LonWorks Network Services (LNS) (LonWorks)

A network management and database standard for CEA-709.1-D devices.

1.4.57 LonWorks Network Services (LNS) Plug-in (LonWorks)

Software which runs in an LNS compatible software tool, typically a network configuration tool. Device configuration plug-ins provide a user friendly method to edit a device's configuration properties.

1.4.58 MAC Address (All protocols)

Media Access Control address. The physical device address that identifies a device on a Local Area Network.

1.4.59 Master-Slave/Token-Passing (MS/TP) (BACnet)

Data link protocol as defined by the BACnet standard. Multiple speeds (data rates) are permitted by the BACnet MS/TP standard.

1.4.60 Monitoring and Control (M&C) Software (All protocols)

The UMCS 'front end' software which performs supervisory functions such as alarm handling, scheduling and data logging and provides a user interface for monitoring the system and configuring these functions.

1.4.61 Network Number (BACnet)

A site-specific number assigned to each network. This network number must be unique throughout the BACnet Internetwork.

1.4.62 Network Variable (LonWorks)

See paragraph STANDARD NETWORK VARIABLE TYPE (SNVT).

1.4.63 Network Configuration Tool (LonWorks)

The software used to configure the control network and set device configuration properties. This software creates and modifies the control network database (LNS Database).

1.4.64 Niagara Framework (Niagara Framework)

A set of hardware and software specifications for building and utility control owned by Tridium Inc. and licensed to multiple vendors. The Framework consists of front end (M&C) software, web based clients, field level control hardware, and engineering tools. While the Niagara Framework is not adopted by a recognized standards body and does not use an open licensing model, it is sufficiently well-supported by multiple HVAC vendors to be considered a de-facto Open Standard.

1.4.65 Niagara Framework Supervisory Gateway (Niagara Framework)

DDC Hardware component of the Niagara Framework. A typical Niagara architecture has Niagara specific supervisory gateways at the IP level and other (non-Niagara specific) controllers on field networks (TP/FT-10, MS/TP, etc.) beneath the Niagara supervisory gateways. The Niagara specific controllers function as a gateway between the Niagara framework protocol (Fox) and the field network beneath. These supervisory gateways may also be used as general purpose controllers and also have the capability to provide a web-based user interface.

Note that different vendors refer to this component by different names. The most common name is "JACE"; other names include (but are not limited to) "EC-BOS", "FX-40", "TMN", "SLX" and "UNC".

1.4.66 Node (LonWorks)

A device that communicates using the CEA-709.1-D protocol and is connected to a CEA-709.1-D network.

1.4.67 Node Address (LonWorks)

The logical address of a node on the network, consisting of a Domain number, Subnet number and Node number. Note that the "Node number" portion of the address is the number assigned to the device during installation and is unique within a subnet. This is not the factory-set unique Node ID (see Node ID).

1.4.68 Node ID (LonWorks)

A unique 48-bit identifier assigned (at the factory) to each CEA-709.1-D device. Sometimes called the Neuron ID.

1.4.69 Object (BACnet)

An ASHRAE 135 Object. The concept of organizing BACnet information into standard components with various associated Properties. Examples include Analog Input objects and Binary Output objects.

1.4.70 Object Identifier (BACnet)

A grouping of two Object properties: Object Type (e.g. Analog Value, Schedule, etc.) and Object Instance (in this case, a number). Object Identifiers must be unique within a device.

1.4.71 Object Instance (BACnet)

See paragraph OBJECT IDENTIFIER

1.4.72 Object Properties (BACnet)

Attributes of an object. Examples include present value and high limit properties of an analog input object. Properties are defined in ASHRAE 135; some are optional and some are required. Objects are controlled by reading from and writing to object properties.

1.4.73 Operator Configurable (All protocols)

Operator configurable values are values that can be changed from a single common front end user interface across multiple vendor systems.

For Niagara Framework Systems, a property, setting, or value is Operator Configurable when it is configurable from a Niagara Framework Front End.

For LNS LonWorks systems, Operator Configurable is defined the same as Configurable. See paragraph CONFIGURABLE.

For non Niagara-based BACnet systems, a property, setting, or value in a device is Operator Configurable when it is Configurable and is either:

- a. a Writable Property of a Standard BACnet Object; or
- b. a Property of a Standard BACnet Object that is Writable when Out_Of_Service is TRUE and Out_Of_Service is Writable.

1.4.74 Override (All protocols)

Changing the value of a point outside of the normal sequence of operation where the change has priority over the sequence and where there is a mechanism for releasing the change such that the point returns to the normal value. Overrides persist until released or overridden at the same or higher priority but are not required to persist through a loss of power. Overrides are often used by operators to change values, and generally originate at a user interface (workstation or local display panel).

1.4.75 Packaged Equipment (All protocols)

Packaged equipment is a single piece of equipment provided by a manufacturer in a substantially complete and operable condition, where the controls (DDC Hardware) are factory installed, and the equipment is sold and shipped from the manufacturer as a single entity. Disassembly and reassembly of a large piece of equipment for shipping does not prevent it from being packaged equipment. Package units may require field installation of remote sensors. Packaged equipment is also called a "packaged unit".

Note industry may use the term "Packaged System" to mean a collection of equipment that is designed to work together where each piece of equipment is packaged equipment and there is a network that connects the equipment together. A "packaged system" of this type is NOT packaged equipment; it is a collection of packaged equipment, and each piece of equipment must individually meet specification requirements.

1.4.76 Packaged Unit (All protocols)

See packaged equipment.

1.4.77 Performance Verification Test (PVT) (All protocols)

The procedure for determining if the installed BAS meets design criteria prior to final acceptance. The PVT is performed after installation, testing, and balancing of mechanical systems. Typically the PVT is performed by the Contractor in the presence of the Government.

1.4.78 Physical Segment (BACnet)

A single contiguous medium to which BACnet devices are attached (ASHRAE 135).

1.4.79 Polling (All protocols)

A device periodically requesting data from another device.

1.4.80 Points (All protocols)

Physical and virtual inputs and outputs. See also paragraph INPUT/OUTPUT (I/O).

1.4.81 Program ID (LonWorks)

An identifier (number) stored in the device that identifies the node manufacturer, functionality of device (application & sequence), transceiver used, and the intended device usage.

1.4.82 Proportional, Integral, and Derivative (PID) Control Loop (All protocols)

Three parameters used to control modulating equipment to maintain a setpoint. Derivative control is often not required for HVAC systems (leaving "PI" control).

1.4.83 Proprietary (BACnet)

Within the context of BACnet, any extension of or addition to object

types, properties, PrivateTransfer services, or enumerations specified in ASHRAE 135. Objects with Object_Type values of 128 and above are Proprietary Objects. Properties with Property_Identifier of 512 and above are proprietary Properties.

1.4.84 Protocol Implementation Conformance Statement (PICS) (BACnet)

A document, created by the manufacturer of a device, which describes which portions of the BACnet standard may be implemented by a given device. ASHRAE 135 requires that all ASHRAE 135 devices have a PICS, and also defines a minimum set of information that must be in it. A device as installed for a specific project may not implement everything in its PICS.

1.4.85 Repeater (All protocols)

A device that connects two control network segments and retransmits all information received on one side onto the other.

1.4.86 Router (All protocols)

A device that connects two CEA-709.1-D channels (in a LonWorks system) or two ASHRAE 135 networks (in a BACnet system) and controls traffic between the two by retransmitting signals received from one side onto the other based on the signal destination. Routers are used to subdivide a LonWorks control network or a BACnet internetwork and to limit network traffic.

1.4.87 Segment (All protocols)

A 'single' section of a control network that contains no repeaters or routers. There is generally a limit on the number of devices on a segment, and this limit is dependent on the topology/media and device type. For example, in a LonWorks system a TP/FT-10 network with locally powered devices is limited to 64 devices per segment.

1.4.88 Service Pin (LonWorks)

A hardware push-button on a device which causes the device to broadcast a message (over the control network) containing its Node ID and Program ID.

1.4.89 Standard BACnet Objects (BACnet)

Objects with Object_Type values below 128 and specifically enumerated in Clause 21 of ASHRAE 135. Objects which are not proprietary. See paragraph PROPRIETARY.

1.4.90 Standard BACnet Properties (BACnet)

Properties with Property_Identifier values below 512 and specifically enumerated in Clause 21 of ASHRAE 135. Properties which are not proprietary. See Proprietary.

1.4.91 Standard BACnet Services (BACnet)

ASHRAE 135 services other than ConfirmedPrivateTransfer or UnconfirmedPrivateTransfer. See paragraph PROPRIETARY.

1.4.92 Standard Configuration Property Type (SCPT) (LonWorks)

Pronounced skip-it. A standard format type (maintained by LonMark

International) for Configuration Properties.

1.4.93 Standard Network Variable Type (SNVT) (LonWorks)

Pronounced snivet. A standard format type (maintained by LonMark International) used to define data information transmitted and received by the individual nodes. The term SNVT is used in two ways. Technically it is the acronym for Standard Network Variable Type, and is sometimes used in this manner. However, it is often used to indicate the network variable itself (i.e. it can mean "a network variable of a standard network variable type"). In general, the intended meaning should be clear from the context.

1.4.94 Subnet (LonWorks)

Consists of a logical grouping of up to 127 nodes, where the logical grouping is defined by node addressing. Each subnet is assigned a number which is unique within the Domain. See also paragraph NODE ADDRESS.

1.4.95 TP/FT-10 (LonWorks)

A Free Topology Twisted Pair network defined by CEA-709.3. This is the most common media type for a CEA-709.1-D control network.

1.4.96 TP/XF-1250 (LonWorks)

A high speed (1.25 Mbps) twisted pair, doubly-terminated bus network defined by the LonMark Interoperability Guidelines. This media is typically used only as a backbone media to connect multiple TP/FT-10 networks.

1.4.97 User-defined Configuration Property Type (UCPT) (LonWorks)

Pronounced u-keep-it. A Configuration Property format type that is defined by the device manufacturer.

1.4.98 User-defined Network Variable Type (UNVT) (LonWorks)

A network variable format defined by the device manufacturer. Note that UNVTs create non-standard communications (other vendor's devices may not correctly interpret it) and may close the system and therefore are not permitted by this specification.

1.4.99 UMCS (All protocols)

UMCS stands for Utility Monitoring and Control System. The term refers to all components by which a project site monitors, manages, and controls real-time operation of HVAC and other building systems. These components include the UMCS "front-end" and all field building control systems connected to the front-end. The front-end consists of Monitoring and Control Software (user interface software), browser-based user interfaces and network infrastructure.

The network infrastructure (the "UMCS Network"), is an IP network connecting multiple building or facility control networks to the Monitoring and Control Software.

1.4.100 UMCS Network (All protocols)

The UMCS Network connects multiple building or facility control networks to the Monitoring and Control Software.

1.4.101 Writable Property (BACnet)

A Property is Writable when it can be changed through the use of one or more of the WriteProperty services defined in ASHRAE 135, Clause 15 regardless of the value of any other Property. Note that in the ASHRAE 135 standard, some Properties may be writable when the Out of Service Property is TRUE; for purposes of this Section, Properties that are only writable when the Out of Service Property is TRUE are not considered to be Writable.

1.5 PROJECT SEQUENCING

TABLE II: PROJECT SEQUENCING lists the sequencing of submittals as specified in paragraph SUBMITTALS (denoted by an 'S' in the 'TYPE' column) and activities as specified in PART 3 EXECUTION (denoted by an 'E' in the 'TYPE' column). TABLE II does not specify overall project milestone and completion dates; these dates are specified in the contract documents.

- a. Sequencing for Submittals: The sequencing specified for submittals is the deadline by which the submittal must be initially submitted to the Government. Following submission there will be a Government review period as specified in Section 01 33 00 SUBMITTAL PROCEDURES. If the submittal is not accepted by the Government, revise the submittal and resubmit it to the Government within 14 days of notification that the submittal has been rejected. Upon resubmittal there will be an additional Government review period. If the submittal is not accepted the process repeats until the submittal is accepted by the Government.
- b. Sequencing for Activities: The sequencing specified for activities indicates the earliest the activity may begin.
- c. Abbreviations: In TABLE II the abbreviation AAO is used for 'after approval of' and 'ACO' is used for 'after completion of'.

TABLE II. PROJECT SEQUENCING			
ITEM #	TYPE	DESCRIPTION	SEQUENCING (START OF ACTIVITY OR DEADLINE FOR SUBMITTAL)
1	S	Existing Conditions Report	
2	S	DDC Contractor Design Drawings	
3	S	Manufacturer's Product Data	14 days AAO #2
4	S	Pre-construction QC Checklist	24 days AAO #3
5	E	Install Building Control System	AAO #1 thru #4

TABLE II. PROJECT SEQUENCING			
ITEM #	TYPE	DESCRIPTION	SEQUENCING (START OF ACTIVITY OR DEADLINE FOR SUBMITTAL)
6	E	Start-Up and Start-Up Testing	ACO #5
7	S	Post-Construction QC Checklist	24 days ACO #6
8	S	Programming Software Configuration Software Niagara Framework Engineering Tool Niagara Framework Wizards XIF Files LNS Plug-Ins	24 days ACO #6
9	S	Draft As-Built Drawings Draft LNS Database	24 days ACO #6
10	S	Start-Up Testing Report	24 days ACO #6
11	S	PVT Procedures	24 days before schedule start of #12 and AAO #10
12	E	Execute PVT	AAO #9 and #11
13	S	PVT Report	24 days ACO #12
14	S	Controller Application Programs Controller Configuration Settings Niagara Framework Supervisory Gateway Backups Final LNS Database	24 days AAO #13
15	S	Final As-Built Drawings	24 days AAO #13
16	S	O&M Instructions	AAO #15
17	S	Training Documentation	AAO #10 and 48 days before scheduled start of #18

TABLE II. PROJECT SEQUENCING			
ITEM #	TYPE	DESCRIPTION	SEQUENCING (START OF ACTIVITY OR DEADLINE FOR SUBMITTAL)
18	E	Training	AAO #16 and #17
19	S	Closeout QC Checklist	ACO #18

1.6 SUBMITTALS

Government approval is required for submittals. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

DDC Contractor Design Drawings

Draft As-Built Drawings

Final As-Built Drawings

SD-03 Product Data

Programming Software

Controller Application Programs

Configuration Software

Controller Configuration Settings

Proprietary Multi-Split Engineering Tool Software

Manufacturer's Product Data

XIF files

Draft LNS Database

Final LNS Database

LNS Plug-ins

Niagara Framework Supervisory Gateway Backups

Niagara Framework Engineering Tool

Niagara Framework Wizards

SD-05 Design Data

Boiler Or Chiller Plant Gateway Request

SD-06 Test Reports

Pre-Construction Quality Control (QC) Checklist

Post-Construction Quality Control (QC) Checklist

Start-Up Testing Report

PVT Procedures

PVT Report

SD-10 Operation and Maintenance Data

Operation and Maintenance (O&M) Instructions

Training Documentation

SD-11 Closeout Submittals

Enclosure Keys

Password Summary Report

Closeout Quality Control (QC) Checklist

1.7 DATA PACKAGE AND SUBMITTAL REQUIREMENTS

Technical data packages consisting of technical data and computer software (meaning technical data which relates to computer software) which are specifically identified in this project and which may be defined/required in other specifications must be delivered strictly in accordance with the CONTRACT CLAUSES and in accordance with the Contract Data Requirements List, DD Form 1423. Data delivered must be identified by reference to the particular specification paragraph against which it is furnished. All submittals not specified as technical data packages are considered 'shop drawings' under the Federal Acquisition Regulation Supplement (FARS) and must contain no proprietary information and be delivered with unrestricted rights.

1.8 SOFTWARE FOR DDC HARDWARE AND GATEWAYS

Provide all software related to the programming and configuration of DDC Hardware and Gateways as indicated. License all Software to the project site. The term "controller" as used in these requirements means both DDC Hardware and Gateways.

1.8.1 Programming Software

For each type of General Purpose Programmable Controller (GPPC), provide the programming software.

For each type of Application Generic Controller (AGC) provided as part of without a configuration and programming Wizard, provide the programming and configuration software

Submit hard copies of user manuals for each software with the software submittal.

Submit Programming Software on CD-ROM as a Technical Data Package.
Submit 4 hard copies of the software user manual for each piece of software.

1.8.2 Controller Application Programs

For each General Purpose Programmable Controller (GPPC), provide copies of the application program as source code compatible with the programming software for that GPPC.

For each Application Generic Controller (AGC), provide copies of the application program as source code compatible with the programming and configuration tool (LNS plug-in) for that AGC

Submit Controller Application Programs on CD-ROM as a Technical Data Package. Include on the CD-ROM a list or table of contents clearly indicating which application program is associated with each device. Submit 2 copies of the Controller Application Programs CD-ROM.

1.8.3 Configuration Software

For each type of controller, provide the configuration tool software in accordance with Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS. Submit hard copies of the software user manuals for each software with the software submittal.

Submit Configuration Software on CD-ROM as a Technical Data Package. Submit 2 hard copies of the software user manual for each piece of software.

1.8.4 Controller Configuration Settings

For each controller, provide copies of the installed configuration settings as source code compatible with the configuration tool software for that controller in accordance with Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS.

Submit Controller Configuration Settings on CD-ROM as a Technical Data Package. Include on the CD-ROM a list or table of contents clearly indicating which files are associated with each device. Submit 2 copies of the Controller Configuration Settings CD-ROM.

1.8.5 Programming Software

For each type of programmable controller, provide the programming software in accordance with Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS. Submit hard copies of software user manuals for each software with the software submittal.

Submit Programming Software on CD-ROM as a Technical Data Package. Submit 2 hard copies of the software user manual for each piece of software.

1.8.6 Controller Application Programs

For each programmable controller, provide copies of the application

program as source code compatible with the programming software for that controller in accordance with Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS.

Submit Controller Application Programs on CD-ROM as a Technical Data Package. Include on the CD-ROM a list or table of contents clearly indicating which application program is associated with each device. Submit 2 copies of the Controller Application Programs CD-ROM.

1.8.7 LNS Plug-Ins (for LNS-based LonWorks systems)

Provide LNS Plug-ins

each Application Specific Controller and each Application Generic Controller. For LNS Plug-ins distributed under a license, license the Plug-In to the project site. Submit hard copy manuals, if available, for each plug-in provided as part of the LNS- Plug-Ins submittal.

Submit LNS Plug-ins on CD-ROM as a Technical Data Package. Include on the CD-ROM a list or table of contents clearly indicating which files are associated with each device.

1.8.8 Niagara Framework Wizards (for Niagara LonWorks systems)

For each Application Generic Controller with a Niagara Framework Wizard and for each Application Specific Controller provide Niagara Framework Wizards.

Submit hard copy manuals, if available, for each Wizard provided as part of the Niagara Framework Wizards submittal.

Submit Niagara Framework Wizards on CD-ROM as a Technical Data Package. Include on the CD-ROM a list or table of contents clearly indicating which files are associated with each device. Submit 2 hard copies of the software user manual, if available, for each Wizard.

1.8.9 Niagara Framework Supervisory Gateway Backups

For each Niagara Framework Supervisory Gateway, provide a backup of all software within the Niagara Framework Supervisory Gateway, including configuration settings. This backup must be sufficient to allow the restoration of the Niagara Framework Supervisory Gateway or the replacement of the Niagara Framework Supervisory Gateway.

Submit backups for each Niagara Framework Supervisory Gateway on CD-ROM as a Technical Data Package. Mark each backup indicating clearly the source Niagara Framework Supervisory Gateway.

1.8.10 Niagara Framework Engineering Tool(for all Niagara Framework system)

Provide a Niagara Framework Engineering Tool in accordance with Section

Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS. Submit software user manuals with the Niagara Framework Engineering Tool submittal.

Submit the Niagara Framework Engineering Tool on CD-ROM as a Technical Data Package. Submit 2 hard copies of the software user manual for the

Niagara Framework Engineering Tool.

1.9 BOILER OR CHILLER PLANT GATEWAY REQUEST

If requesting the use of a gateway to a boiler or chiller plant as indicated in paragraph Proprietary Systems Exempted From Open Protocol Requirements, submit a Boiler or Chiller Plant Gateway Request describing the configuration of the boilers or chillers including model numbers for equipment and controllers, the sequence of operation for the units, and a justification for the need to operate the units on a shared non-LonWorks non-BACnet network.

1.10 QUALITY CONTROL CHECKLISTS

The QC Checklist for LNS-Based LonWorks Systems in APPENDIX A of this Section must be completed by the Contractor's Chief Quality Control (QC) Representative and submitted as indicated.

The QC Checklist for Niagara Framework Based LonWorks Systems in APPENDIX A of this Section must be completed by the Contractor's Chief Quality Control (QC) Representative and submitted as indicated.

The QC Checklist for BACnet Systems in APPENDIX A of this Section must be completed by the Contractor's Chief Quality Control (QC) Representative and submitted as indicated.

The QC Checklist for Niagara Framework Based BACnet Systems in APPENDIX A of this Section must be completed by the Contractor's Chief Quality Control (QC) Representative and submitted as indicated.

The QC Representative must verify each item indicated and initial in the space provided to indicate that the requirement has been met. The QC Representative must sign and date the Checklist prior to submission to the Government.

1.10.1 Pre-Construction Quality Control (QC) Checklist

Complete items indicated as Pre-Construction QC Checklist items in the QC Checklist. Submit four copies of the Pre-Construction QC Checklist.

1.10.2 Post-Construction Quality Control (QC) Checklist

Complete items indicated as Post-Construction QC Checklist items in the QC Checklist. Submit four copies of the Post-Construction QC Checklist.

1.10.3 Closeout Quality Control (QC) Checklist

Complete items indicated as Closeout QC Checklist items in the QC Checklist. Submit four copies of the Closeout QC Checklist.

PART 2 PRODUCTS

Provide products meeting the requirements of Section 23 09 13
INSTRUMENTATION AND CONTROL DEVICES FOR HVAC,

LonWorks systems or Niagara LonWorks systems, Section 23 09 23.02 BACNET
DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS for

BACnet or Niagara BACnet systems, other referenced Sections, and this Section.

2.1 GENERAL PRODUCT REQUIREMENTS

Units of the same type of equipment must be products of a single manufacturer. Each major component of equipment must have the manufacturer's name and address, and the model and serial number in a conspicuous place. Materials and equipment must be standard products of a manufacturer regularly engaged in the manufacturing of these and similar products. The standard products must have been in a satisfactory commercial or industrial use for two years prior to use on this project. The two year use must include applications of equipment and materials under similar circumstances and of similar size. DDC Hardware not meeting the two-year field service requirement is acceptable provided it has been successfully used by the Contractor in a minimum of two previous projects. The equipment items must be supported by a service organization. Items of the same type and purpose must be identical, including equipment, assemblies, parts and components.

2.2 PRODUCT DATA

Provide manufacturer's product data sheets documenting compliance with product specifications for each product provided under Section 23 09 13 INSTRUMENTATION AND CONTROL DEVICES FOR HVAC,

Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS, or this Section. Provide product data for all products in a single indexed compendium, organized by product type.

For all LonWorks hardware: for each manufacturer, model and version (revision) of DDC Hardware indicate the type or types of DDC Hardware the product is being provided

For all BACnet hardware: for each manufacturer, model and version (revision) of DDC Hardware provide the Protocol Implementation Conformance Statement (PICS) in accordance with Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS.

Submit Manufacturer's Product Data on CD-ROM.

2.2.1 XIF Files

Provide External Interface Files (XIF Files) for DDC Hardware

Submit external interface files (XIF files) as a technical data package for each model of DDC Hardware provided under this specification. Submit XIF files on CD-ROM.

2.3 OPERATION ENVIRONMENT

Unless otherwise specified, provide products rated for continuous operation under the following conditions:

- a. Pressure: Pressure conditions normally encountered in the installed location.
- b. Vibration: Vibration conditions normally encountered in the installed

location.

c. Temperature:

- (1) Products installed indoors: Ambient temperatures in the range of 32 to 112 degrees F and temperature conditions outside this range normally encountered at the installed location.
- (2) Products installed outdoors or in unconditioned indoor spaces: Ambient temperatures in the range of -35 to +151 degrees F and temperature conditions outside this range normally encountered at the installed location.

- d. Humidity: 10 to 95 percent relative humidity, noncondensing and humidity conditions outside this range normally encountered at the installed location.

2.4 WIRELESS CAPABILITY

For products incorporating any wireless capability (including but not limited to radio frequency (RF), infrared and optical), provide products for which wireless capability can be permanently disabled at the device. Optical and infrared capabilities may be disabled via a permanently affixed opaque cover plate.

2.5 ENCLOSURES

Enclosures supplied as an integral (pre-packaged) part of another product are acceptable. Provide two Enclosure Keys for each lockable enclosure on a single ring per enclosure with a tag identifying the enclosure the keys operate. Provide enclosures meeting the following minimum requirements:

2.5.1 Outdoors

For enclosures located outdoors, provide enclosures meeting NEMA 250 Type 3 requirements.

2.5.2 Mechanical and Electrical Rooms

For enclosures located in mechanical or electrical rooms, provide enclosures meeting NEMA 250 Type 2 requirements.

2.5.3 Other Locations

For enclosures in other locations including but not limited to occupied spaces, above ceilings, and in plenum returns, provide enclosures meeting NEMA 250 Type 1 requirements.

2.6 WIRE AND CABLE

Provide wire and cable meeting the requirements of NFPA 70 and NFPA 90A in addition to the requirements of this specification and referenced specifications.

2.6.1 Terminal Blocks

For terminal blocks which are not integral to other equipment, provide terminal blocks which are insulated, modular, feed-through, clamp style with recessed captive screw-type clamping mechanism, suitable for DIN rail

mounting, and which have enclosed sides or end plates and partition plates for separation.

2.6.2 Control Wiring for Binary Signals

For Control Wiring for Binary Signals, provide 18 AWG copper or thicker wire rated for 300-volt service.

2.6.3 Control Wiring for Analog Signals

For Control Wiring for Analog Signals, provide 18 AWG or thicker, copper, single- or multiple-twisted wire meeting the following requirements:

- a. minimum 2 inch lay of twist
- b. 100 percent shielded pairs
- c. at least 300-volt insulation
- d. each pair has a 20 AWG tinned-copper drain wire and individual overall pair insulation
- e. cables have an overall aluminum-polyester or tinned-copper cable-shield tape, overall 20 AWG tinned-copper cable drain wire, and overall cable insulation.

2.6.4 Power Wiring for Control Devices

For 24-volt circuits, provide insulated copper 18 AWG or thicker wire rated for 300 VAC service. For 120-volt circuits, provide 14 AWG or thicker stranded copper wire rated for 600-volt service.

2.6.5 Transformers

Provide UL 5085-3 approved transformers. Select transformers sized so that the connected load is no greater than 80 percent of the transformer rated capacity.

PART 3 EXECUTION

3.1 INSTALLATION

Fully install and test the control system in accordance Section 23 09 13 INSTRUMENTATION AND CONTROL DEVICES FOR HVAC

Section 23 09 23.02 BACNET

DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS for BACnet or Niagara BACnet systems, and this Section.

3.1.1 Dielectric Isolation

Provide dielectric isolation where dissimilar metals are used for connection and support. Install control system in a manner that provides clearance for control system maintenance by maintaining access space required to calibrate, remove, repair, or replace control system devices. Install control system such that it does not interfere with the clearance requirements for mechanical and electrical system maintenance.

3.1.2 Penetrations in Building Exterior

Make all penetrations through and mounting holes in the building exterior watertight.

3.1.3 Device Mounting Criteria

Install devices in accordance with the manufacturer's recommendations and as indicated and shown. Provide a weathershield for all devices installed outdoors. Provide clearance for control system maintenance by maintaining access space required to calibrate, remove, repair, or replace control system devices. Provide clearance for mechanical and electrical system maintenance; do not not interfere with the clearance requirements for mechanical and electrical system maintenance.

3.1.4 Labels and Tags

Key all labels and tags to the unique identifiers shown on the As-Built drawings. For labels exterior to protective enclosures provide engraved plastic labels mechanically attached to the enclosure or DDC Hardware. Labels inside protective enclosures may be attached using adhesive, but must not be hand written. For tags, provide plastic or metal tags mechanically attached directly to each device or attached by a metal chain or wire.

- a. Label all Enclosures and DDC Hardware.
- b. Tag Airflow measurement arrays (AFMA) with flow rate range for signal output range, duct size, and pitot tube AFMA flow coefficient.
- c. Tag duct static pressure taps at the location of the pressure tap

3.1.5 Surge Protection

3.1.5.1 Power-Line Surge Protection

Protect equipment connected to AC circuits to withstand power-line surges in accordance with [IEEE C62.41](#). Do not use fuses for surge protection.

3.1.5.2 Surge Protection for Transmitter and Control Wiring

Protect DDC hardware against or provided DDC hardware capable of withstanding surges induced on control and transmitter wiring installed outdoors and as shown. Protect equipment against the following two waveforms:

- a. A waveform with a 10-microsecond rise time, a 1000-microsecond decay time and a peak current of 60 amps.
- b. A waveform with an 8-microsecond rise time, a 20-microsecond decay time and a peak current of 500 amperes.

3.1.6 Basic Cybersecurity Requirements

3.1.6.1 Passwords

For all devices with a password, change the password from the default password. Do not use the same password for more than one device. Coordinate selection of passwords with [Contracting Officer](#). Provide a

[Password Summary Report](#) documenting the password for each device and describing the procedure to change the password for each device.

Provide two hardcopies of the Password Summary Report, each copy in its own sealed envelope.

3.1.6.2 Wireless Capability

Unless otherwise indicated, disable wireless capability (including but not limited to radio frequency (RF), infrared and optical) for all devices with wireless capability. Optical and infrared capabilities may be disabled via a permanently affixed opaque cover plate. Password protecting a wireless connections does not meet this requirement; the wireless capability must be disabled.

3.1.6.3 IP Network Physical Security

Install all IP Network media in conduit. Install all IP devices including but not limited to IP-enabled DDC hardware and IP Network Hardware in lockable enclosures.

3.2 DRAWINGS AND CALCULATIONS

Provide drawings in the form and arrangement indicated and shown. Use the same abbreviations, symbols, nomenclature and identifiers shown. Assign a unique identifier as shown to each control system element on a drawing. When packaging drawings, group schedules by system. When space allows, it is permissible to include multiple schedules for the same system on a single sheet. Except for drawings covering all systems, do not put information for different systems on the same sheet.

Submit hardcopy drawings on or sheets, and electronic drawings in PDF and in AutoCAD format. In addition, submit electronic drawings in editable Excel format for all drawings that are tabular, including but not limited to the Point Schedule and Equipment Schedule.

- a. Submit [DDC Contractor Design Drawings](#) consisting of each drawing indicated with pre-construction information depicting the intended control system design and plans. Submit DDC Contractor Design Drawings as a single complete package: 2 hard copies and 2 copies on CD-ROM.
- b. Submit [Draft As-Built Drawings](#) consisting of each drawing indicated updated with as-built data for the system prior to PVT. Submit Draft As-Built Drawings as a single complete package: 2 hard copies and 2 copies on CD-ROM.
- c. Submit [Final As-Built Drawings](#) consisting of each drawing indicated updated with all final as-built data. Final As-Built Drawings as a single complete package: 2 hard copies and 2 copies on CD-ROM.

3.2.1 Sample Drawings

Sample drawings in electronic format are available at the Whole Building Design Guide page for this section:

<http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-23-09-00>

These drawings may prove useful in demonstrating expected drawing formatting and example content and are provided for illustrative purposes only. Note that these drawings do not meet the content requirements of

this Section and must be completed to meet project requirements.

3.2.2 Drawing Index and Legend

Provide an HVAC Control System Drawing Index showing the name and number of the building, military site, State or other similar designation, and Country. In the Drawing Index, list all Contractor Design Drawings, including the drawing number, sheet number, drawing title, and computer filename when used. In the Design Drawing Legend, show and describe all symbols, abbreviations and acronyms used on the Design Drawings. Provide a single Index and Legend for the entire drawing package.

3.2.3 Thermostat and Occupancy Sensor Schedule

Provide a thermostat and occupancy sensor schedule containing each thermostat's unique identifier, room identifier and control features and functions as shown. Provide a single thermostat and occupancy sensor schedule for the entire project.

3.2.4 Valve Schedule

Provide a valve schedule containing each valve's unique identifier, size, flow coefficient Kv (Cv), pressure drop at specified flow rate, spring range, positive positioner range, actuator size, close-off pressure to torque data, dimensions, and access and clearance requirements data. In the valve schedule include actuator selection data supported by calculations of the force required to move and seal the valve, access and clearance requirements. Provide a single valve schedule for the entire project.

3.2.5 Damper Schedule

Provide a damper schedule containing each damper's unique identifier, type (opposed or parallel blade), nominal and actual sizes, orientation of axis and frame, direction of blade rotation, actuator size and spring ranges, operation rate, positive positioner range, location of actuators and damper end switches, arrangement of sections in multi-section dampers, and methods of connecting dampers, actuators, and linkages. Include the AMCA 511 maximum leakage rate at the operating static-pressure differential for each damper in the Damper Schedule. Provide a single damper schedule for the entire project.

3.2.6 Project Summary Equipment Schedule

Provide a project summary equipment schedule containing the manufacturer, model number, part number and descriptive name for each control device, hardware and component provided under this specification. Provide a single project equipment schedule for the entire project.

3.2.7 Equipment Schedule

Provide system equipment schedules containing the unique identifier, manufacturer, model number, part number and descriptive name for each control device, hardware and component provided under this specification. Provide a separate equipment schedule for each HVAC system.

3.2.8 Occupancy Schedule

Provide an occupancy schedule drawing containing the same fields as the

occupancy schedule Contract Drawing with Contractor updated information.
Provide a single occupancy schedule for the entire project.

3.2.9 DDC Hardware Schedule

Provide a single DDC Hardware Schedule for the entire project and including following information for each device.

3.2.9.1 DDC Hardware Identifier

The Unique DDC Hardware Identifier for the device.

3.2.9.2 HVAC System

The system "name" used to identify a specific system (the name used on the system schematic drawing for that system).

3.2.9.3 LonWorks Device Information

3.2.9.3.1 Network Address

The LonWorks Domain, Subnet and Node address for the device.

3.2.9.3.2 Unique Node ID

The Unique 48-bit Node ID associated with the device. (Also referred to as the Neuron ID for some devices)

3.2.9.4 BACnet Device Information

3.2.9.4.1 Device Object Identifier

The Device Object Identifier: The Object_Identifier of the Device Object

3.2.9.4.2 Network Number

The Network Number for the device.

3.2.9.4.3 MAC Address

The MAC Address for the device

3.2.9.4.4 BTL Listing

The BTL Listing of the device. If the device is listed under multiple BTL Profiles, indicate the profile that matches the use and configuration of the device as installed.

3.2.9.4.5 Proprietary Services Information

If the device uses non-standard **ASHRAE 135** services as defined and permitted in Section **23 09 23.02** BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS, indicate that the device uses non-standard services and include a description of all non-standard services used. Describe usage and content such that a device from another vendor can interoperate with the device using the non-standard service. Provide descriptions with sufficient detail to allow a device from a different manufacturer to be programmed to both read and write the non-standard service request:

- a. read: interpret the data contained in the non-standard service and;
- b. write: given similar data, generate the appropriate non-standard service request.

3.2.9.4.6 Alarming Information

Indicate whether the device is used for alarm generation, and which types of alarm generation the device implements: intrinsic, local algorithmic, remote algorithmic.

3.2.9.4.7 Scheduling Information

Indicate whether the device is used for scheduling.

3.2.9.4.8 Trending Information

Indicate whether the device is used for trending, and indicate if the device is used to trend local values, remote values, or both.

3.2.9.5 Niagara Station ID

The Niagara Station ID for each Niagara Framework Supervisory Gateway

3.2.10 Points Schedule

Provide a Points Schedule in tabular form for each HVAC system, with the indicated columns and with each row representing a hardware point, network point or configuration point in the system.

- a. When a Points Schedule was included in the Contract Drawing package, use the same fields as the Contract Drawing with updated information in addition to the indicated fields.
- b. When Point Schedules are included in the contract package, items requiring contractor verification or input have been shown in angle brackets ("<" and ">"), such as <___> for a required entry or <value> for a value requiring confirmation. Complete all items in brackets as well as any blank cells. Do not modify values which are not in brackets without approval.

Points Schedule Columns must include:

3.2.10.1 Point Name

The abbreviated name for the point using the indicated naming convention.

3.2.10.2 Description

A brief functional description of the point such as "Supply Air Temperature".

3.2.10.3 DDC Hardware Identifier

The Unique DDC Hardware Identifier shown on the DDC Hardware Schedule and used across all drawings for the DDC Hardware containing the point.

3.2.10.4 Settings

The value and units of any setpoints, configured setpoints, configuration parameters, and settings related to each point.

3.2.10.5 Range

The range of values, including units, associated with the point, including but not limited to a zone temperature setpoint adjustment range, a sensor measurement range, occupancy values for an occupancy input, or the status of a safety.

3.2.10.6 Input or Output (I/O) Type

The type of input or output signal associated with the point. Use the following abbreviations for entries in this column:

- a. AI: The value comes from a hardware (physical) Analog Input
- b. AO: The value is output as a hardware (physical) Analog Output
- c. BI: The value comes from a hardware (physical) Binary Input
- d. BO: The value is output as a hardware (physical) Binary Output
- e. PULSE: The value comes from a hardware (physical) Pulse Accumulator Input
- f. NET-IN: The value is provided from the network (generally from another device). Use this entry only when the value is received from another device as part of scheduling or as part of a sequence of operation, not when the value is received on the network for supervisory functions such as trending, alarming, override or display at a user interface.
- g. NET-OUT: The value is provided to another controller over the network. Use this entry only when the value is transmitted to another device as part of scheduling or as part of a sequence of operation, not when the value is transmitted on the network for supervisory functions such as trending, alarming, override or display at a user interface.

3.2.10.7 Object and Property Information

The Object Type and Instance Number for the Object associated with the point. If the value of the point is not in the Present_Value Property, then also provide the Property ID for the Property containing the value of the point. Any point that is displayed at the front end or on an LDP, is trended, is used by another device on the network, or has an alarm condition must be documented here.

3.2.10.8 Primary Point Information: SNVT Name

The name of the SNVT used for the point. Any point that is displayed at the front end or on an LDP, is trended, is used by another device on the network, or has an alarm condition must be documented here.

3.2.10.9 Primary Point Information: SNVT Type

The SNVT type used by the point. Provide this information whenever SNVT Name is required.

3.2.10.10 Niagara Station ID

The Niagara Station ID of the Niagara Framework Supervisory Gateway the point is mapped into.

3.2.10.11 Network Data Exchange Information (Gets Data From, Sends Data To)

Provide the DDC Hardware Identifier of other DDC Hardware the point is shared with.

3.2.10.12 Override Information (Object Type and Instance Number)

For each point requiring an Override and not residing in a Niagara Framework Supervisory Gateway, indicate if the Object for the point is Commandable or, if the use of a separate Object was specifically approved by the Contracting Officer, provide the Object Type and Instance Number of the Object to be used in overriding the point.

3.2.10.13 Override Information (SNVT Name and Type)

For each point requiring an Override and not residing in a Niagara Framework Supervisory Gateway, indicate the SNVT Name and SNVT Type of the network variable used for the override.

3.2.10.14 Trend Object Information

For each point requiring a trend, indicate if the trend is Local or Remote, the trend Object type and the trend Object instance number. For remote trends provide the DDC Hardware Identifier for the device containing the trend Object in the Points Schedule notes.

3.2.10.15 Alarm Information

Indicate the Alarm Generation Type, Event Enrollment Object Instance Number, and Notification Class Object Instance Number for each point requiring an alarm. (Note that not all alarms will have Event Enrollment Objects.)

For Niagara BACnet systems: Indicate the Alarm Generation Type and Notification Class Object Instance Number for each point requiring an alarm. (Note that not all alarms will have a Notification Class Object.)

3.2.10.16 Configuration Information

Indicate the means of configuration associated with each point. For points in a Niagara Framework Supervisory Gateway, indicate the point within the Niagara Framework Supervisory Gateway used to configure the value. For other points:

- a. For Operator Configurable Points indicate BACnet Object and Property information (Name, Type, Identifiers) containing the configurable value. Indicate whether the property is writable always, or only when Out_Of_Service is TRUE.

- b. For Configurable Points indicate the BACnet Object and Property information as for Operator Configurable points, or identification of the configurable settings from within the engineering software for the device or identification of the hardware settings on the device.
- a. Indicate "Plug-In" if the point is configurable via an LNS plug-in. Indicate "Niagara Framework Wizard" if the point is configurable via a Niagara Framework Wizard.
- b. If the point is not configurable through an LNS plug-in a Niagara Framework Wizard, indicate the network variable or configuration property used to configure the value.

3.2.11 Riser Diagram

The Riser Diagram of the Building Control Network may be in tabular form, and must show all DDC Hardware and all Network Hardware, including network terminators. For each item, provide the unique identifier, common descriptive name, physical sequential order (previous and next device on the network), room identifier and location within room. A single riser diagram must be submitted for the entire system.

3.2.12 Control System Schematics

Provide control system schematics in the same form as the control system schematic Contract Drawing with Contractor updated information. Provide a control system schematic for each HVAC system.

3.2.13 Sequences of Operation Including Control Logic Diagrams

Provide HVAC control system sequence of operation and control logic diagrams in the same format as the Contract Drawings. Within these drawings, refer to devices by their unique identifiers. Submit sequences of operation and control logic diagrams for each HVAC system

3.2.14 Controller, Motor Starter and Relay Wiring Diagram

Provide controller wiring diagrams as functional wiring diagrams which show the interconnection of conductors and cables to each controller and to the identified terminals of input and output devices, starters and package equipment. Show necessary jumpers and ground connections and the labels of all conductors. Identify sources of power required for control systems and for packaged equipment control systems back to the panel board circuit breaker number, controller enclosures, magnetic starter, or packaged equipment control circuit. Show each power supply and transformer not integral to a controller, starter, or packaged equipment. Show the connected volt-ampere load and the power supply volt-ampere rating. Provide wiring diagrams for each HVAC system.

3.3 CONTROLLER TUNING

Tune each controller in a manner consistent with that described in the **ASHRAE FUN IP** and in the manufacturer's instruction manual. Tuning must consist of adjustment of the proportional, integral, and where applicable, the derivative (PID) settings to provide stable closed-loop control. Each loop must be tuned while the system or plant is operating at a high gain (worst case) condition, where high gain can generally be defined as a low-flow or low-load condition. Upon final adjustment of the PID settings, in response to a change in controller setpoint, the controlled

variable must settle out at the new setpoint with no more than two (2) oscillations above and below setpoint. Upon settling out at the new setpoint the controller output must be steady. With the exception of naturally slow processes such as zone temperature control, the controller must settle out at the new setpoint within five (5) minutes. Set the controller to its correct setpoint and record and submit the final PID configuration settings with the O&M Instructions and on the associated Points Schedule.

3.4 START-UP

3.4.1 Start-Up Test

Perform the following startup tests for each control system to ensure that the described control system components are installed and functioning per this specification.

Adjust, calibrate, measure, program, configure, set the time schedules, and otherwise perform all necessary actions to ensure that the systems function as indicated and shown in the sequence of operation and other contract documents.

3.4.1.1 Systems Check

An item-by-item check must be performed for each HVAC system

3.4.1.1.1 Step 1 - System Inspection

With the system in unoccupied mode and with fan hand-off-auto switches in the OFF position, verify that power and main air are available where required and that all output devices are in their failsafe and normal positions. Inspect each local display panel and each M&C Client to verify that all displays indicate shutdown conditions.

3.4.1.1.2 Step 2 - Calibration Accuracy Check

Perform a two-point accuracy check of the calibration of each HVAC control system sensing element and transmitter by comparing the value from the test instrument to the network value provided by the DDC Hardware. Use digital indicating test instruments, such as digital thermometers, motor-driven psychrometers, and tachometers. Use test instruments with accuracy at least twice as accurate as the specified sensor accuracy and with calibration traceable to National Institute of Standards and Technology standards. Check one the first check point in the bottom one-third of the sensor range, and the second in the top one-third of the sensor range. Verify that the sensing element-to-DDC readout accuracies at two points are within the specified product accuracy tolerances, and if not recalibrate or replace the device and repeat the calibration check.

3.4.1.1.3 Step 3 - Actuator Range Check

With the system running, apply a signal to each actuator through the DDC Hardware controller. Verify proper operation of the actuators and positioners for all actuated devices and record the signal levels for the extreme positions of each device. Vary the signal over its full range, and verify that the actuators travel from zero stroke to full stroke within the signal range. Where applicable, verify that all sequenced actuators move from zero stroke to full stroke in the proper direction, and move the connected device in the proper direction from one extreme

position to the other. For valve actuators and damper actuators, perform the actuator range check under normal system pressures.

3.4.1.2 Weather Dependent Test

Perform weather dependent test procedures in the appropriate climatic season.

3.4.2 Start-Up Testing Report

Submit 4 copies of the Start-Up Testing Report. The report may be submitted as a Technical Data Package documenting the results of the tests performed and certifying that the system is installed and functioning per this specification, and is ready for the Performance Verification Test (PVT).

3.4.3 Draft LNS Database

Upon completion of the Start-Up Test, submit the Draft LNS Database reflecting the system as installed and configured at the completion of the Start-Up and Start-Up-Testing. The Draft LNS Database must be a complete, fully commissioned LNS database for the complete control network provided under this specification. The Draft LNS database submittal must consist of the entire folder structure of the LNS database (e.g. c:\Lm\DB\{database name}). For versions of LNS which use credits, the provided LNS Database must include all device credits.

Submit two copies of the fully commissioned, valid draft LNS Database (including all LNS credits) as a Technical Data Package. Submit each copy on a CD-ROM and clearly mark the CD-ROM identifying it as the LNS Database for the work covered under this specification and with the date of the most recent database modification.

3.5 PERFORMANCE VERIFICATION TEST (PVT)

3.5.1 PVT Procedures

Prepare PVT Procedures based on Section 25 08 10 UTILITY MONITORING AND CONTROL SYSTEM TESTING explaining step-by-step, the actions and expected results that will demonstrate that the control system performs in accordance with the sequences of operation, and other contract documents. Submit 4 copies of the PVT Procedures. The PVT Procedures may be submitted as a Technical Data Package.

3.5.1.1 Sensor Accuracy Checks

Include a one-point accuracy check of each sensor in the PVT procedures.

3.5.1.2 Temporary Trending Hardware

Unless trending capability exists within the building control system or the building control system is connected to a UMCS or other system which can perform trending, temporarily install hardware on the building control network to perform trending during the endurance test as indicated. Remove the temporary hardware at the completion of all commissioning activities.

3.5.1.3 Endurance Test

Include a one-week endurance test as part of the PVT during which the system is operated continuously.

Use the building control system BACnet Trend Log or Trend Log Multiple Objects to trend all points shown as requiring a trend on the Point Schedule for the entire endurance test. If insufficient buffer capacity exists to trend the entire endurance test, upload trend logs during the course of the endurance test to ensure that no trend data is lost.

Use the building control system Niagara Trend Log Objects to trend all points shown as requiring a trend on the Point Schedule for the entire endurance test. If insufficient buffer capacity exists to trend the entire endurance test, upload trend logs during the course of the endurance test to ensure that no trend data is lost. The PVT must include a methodology to measure and record the network bandwidth usage on each TP/FT-10 channel during the endurance test.

Use the existing trending capabilities or the Temporary Trending Hardware as indicated to trend all points shown as requiring a trend on the Point Schedule for the entire endurance test. The PVT must include a methodology to measure and record the network bandwidth usage on each TP/FT-10 channel during the endurance test.

3.5.1.4 PVT Equipment List

Include in the PVT procedures a control system performance verification test equipment list that lists the equipment to be used during performance verification testing. For each piece of equipment, include manufacturer name, model number, equipment function, the date of the latest calibration, and the results of the latest calibration

3.5.2 PVT Execution

Demonstrate compliance of the control system with the contract documents. Using test plans and procedures approved by the Government, software capable of reading and writing COV Notification Subscriptions, Notification Class Recipient List Properties, event enrollments, demonstrate all physical and functional requirements of the project. Show, step-by-step, the actions and results demonstrating that the control systems perform in accordance with the sequences of operation. Do not start the performance verification test until after receipt of written permission by the Government, based on Government approval of the PVT Plan and Draft As-Builts and completion of balancing. UNLESS GOVERNMENT WITNESSING OF A TEST IS SPECIFICALLY WAIVED BY THE GOVERNMENT, PERFORM ALL TESTS WITH A GOVERNMENT WITNESS. Do not conduct tests during scheduled seasonal off periods of base heating and cooling systems. If the system experiences any failures during the endurance test portion of the PVT, repair the system repeat the endurance test portion of the PVT until the system operates continuously and without failure for the specified endurance test period.

3.5.3 PVT Report

Prepare and submit a PVT report documenting all tests performed during the

PVT and their results. Include all tests in the PVT procedures and any additional tests performed during PVT. Document test failures and repairs conducted with the test results.

Submit four copies of the PVT Report. The PVT Report may be submitted as a Technical Data Package.

3.5.4 Final LNS Database

Submit a Final LNS Database consisting of the complete, fully commissioned LNS database for the complete control network provided under this specification. Provide the the entire folder structure of the LNS database (e.g. c:\Lm\DB\{database name}. For versions of LNS which use credits, include all device credits in the provided LNS Database.

Submit two copies of the fully commissioned, valid as-built LNS Database (including all LNS credits) for the complete control network provided under this specification as a Technical Data Package. Submit each copy on CD-ROM and clearly mark the CD-ROM identifying it as the LNS Database for the work covered under this specification and with the date of the most recent database modification.

3.6 OPERATION AND MAINTENANCE (O&M) INSTRUCTIONS

Provide HVAC control System Operation and Maintenance Instructions which include:

- a. "Data Package 3" as indicated in Section 01 78 23 OPERATION AND MAINTENANCE DATA for each piece of control equipment.
- b. "Data Package 4" as described in Section 01 78 23 OPERATION AND MAINTENANCE DATA for all air compressors.
- c. HVAC control system sequences of operation formatted as indicated.
- d. Procedures for the HVAC system start-up, operation and shut-down including the manufacturer's supplied procedures for each piece of equipment, and procedures for the overall HVAC system.
- e. As-built HVAC control system detail drawings formatted as indicated.
- f. Routine maintenance checklist. Provide the routine maintenance checklist arranged in a columnar format, where the first column lists all installed devices, the second column states the maintenance activity or that no maintenance required, the third column states the frequency of the maintenance activity, and the fourth column is used for additional comments or reference.
- g. Qualified service organization list, including at a minimum company name, contact name and phone number.
- h. Start-Up Testing Report.
- i. Performance Verification Test (PVT) Procedures and Report.

Submit 2 copies of the Operation and Maintenance Instructions, indexed and in booklet form. The Operation and Maintenance Instructions may be

submitted as a Technical Data Package.

3.7 MAINTENANCE AND SERVICE

Provide services, materials and equipment as necessary to maintain the entire system in an operational state as indicated for a period of one year from the date of final acceptance of the project. Minimize impacts on facility operations.

- a. The integration of the system specified in this section into a Utility Monitoring and Control System must not, of itself, void the warranty or otherwise alter the requirement for the one year maintenance and service period. Integration into a UMCS includes but is not limited to establishing communication between devices in the control system and the front end or devices in another system.
- b. The changing of configuration properties must not, of itself, void the warranty or otherwise alter the requirement for the one year maintenance and service period.

3.7.1 Description of Work

Provide adjustment and repair of the system including the manufacturer's required sensor and actuator (including transducer) calibration, span and range adjustment.

3.7.2 Personnel

Use only service personnel qualified to accomplish work promptly and satisfactorily. Advise the Government in writing of the name of the designated service representative, and of any changes in personnel.

3.7.3 Scheduled Inspections

Perform two inspections at six-month intervals and provide work required. Perform inspections in June and December. During each inspection perform the indicated tasks:

- a. Perform visual checks and operational tests of equipment.
- b. Clean control system equipment including interior and exterior surfaces.
- c. Check and calibrate each field device. Check and calibrate 50 percent of the total analog inputs and outputs during the first inspection. Check and calibrate the remaining 50 percent of the analog inputs and outputs during the second major inspection. Certify analog test instrumentation accuracy to be twice the specified accuracy of the device being calibrated. Randomly check at least 25 percent of all binary inputs and outputs for proper operation during the first inspection. Randomly check at least 25 percent of the remaining binary inputs and outputs during the second inspection. If more than 20 percent of checked inputs or outputs failed the calibration check during any inspection, check and recalibrate all inputs and outputs during that inspection.
- d. Run system software diagnostics and correct diagnosed problems.
- e. Resolve any previous outstanding problems.

3.7.4 Scheduled Work

This work must be performed during regular working hours, Monday through Friday, excluding Federal holidays.

3.7.5 Emergency Service

The Government will initiate service calls when the system is not functioning properly. Qualified personnel must be available to provide service to the system. A telephone number where the service supervisor can be reached at all times must be provided. Service personnel must be at the site within 24 hours after receiving a request for service. The control system must be restored to proper operating condition as required per Section 01 78 00 CLOSEOUT SUBMITTALS.

3.7.6 Operation

After performing scheduled adjustments and repairs, verify control system operation as demonstrated by the applicable tests of the performance verification test.

3.7.7 Records and Logs

Keep dated records and logs of each task, with cumulative records for each major component, and for the complete system chronologically. Maintain a continuous log for all devices, including initial analog span and zero calibration values and digital points. Keep complete logs and provide logs for inspection onsite, demonstrating that planned and systematic adjustments and repairs have been accomplished for the control system.

3.7.8 Work Requests

Record each service call request as received and include its location, date and time the call was received, nature of trouble, names of the service personnel assigned to the task, instructions describing what has to be done, the amount and nature of the materials to be used, the time and date work started, and the time and date of completion. Submit a record of the work performed within 5 days after work is accomplished.

3.7.9 System Modifications

Submit recommendations for system modification in writing. Do not make system modifications, including operating parameters and control settings, without prior approval of the Government.

3.8 TRAINING

Conduct a training course for 3 operating staff members designated by the Government in the maintenance and operation of the system, including specified hardware and software. Conduct 32 hours of training at the project site within 30 days after successful completion of the performance verification test. The Government reserves the right to make audio and visual recordings (using Government supplied equipment) of the training sessions for later use. Provide audiovisual equipment and other training materials and supplies required to conduct training. A training day is defined as 8 hours of classroom instruction, including two 15 minute breaks and excluding lunchtime, Monday through Friday, during the daytime shift in effect at the training facility.

3.8.1 Training Documentation

Prepare training documentation consisting of:

- a. Course Attendee List: Develop the list of course attendees in coordination with and signed by the Controls shop supervisor.
- b. Training Manuals: Provide training manuals which include an agenda, defined objectives for each lesson, and a detailed description of the subject matter for each lesson. When presenting portions of the course material by audiovisuals, deliver copies of those audiovisuals as a part of the printed training manuals.

3.8.2 Training Course Content

For guidance in planning the required instruction, assume that attendees will have a high school education, and are familiar with HVAC systems. During the training course, cover all of the material contained in the Operating and Maintenance Instructions, the layout and location of each controller enclosure, the layout of one of each type of equipment and the locations of each, the location of each control device external to the panels, the location of the compressed air station, preventive maintenance, troubleshooting, diagnostics, calibration, adjustment, commissioning, tuning, and repair procedures. Typical systems and similar systems may be treated as a group, with instruction on the physical layout of one such system. Present the results of the performance verification test and the Start-Up Testing Report as benchmarks of HVAC control system performance by which to measure operation and maintenance effectiveness.

3.8.3 Training Documentation Submittal Requirements

Submit hardcopy training manuals and all training materials on CD-ROM. Provide one hardcopy manual for each trainee on the Course Attendee List and 2 additional copies for archive at the project site. Provide 2 copies of the Course Attendee List with the archival copies. Training Documentation may be submitted as a Technical Data Package.

APPENDIX A

<u>QC CHECKLIST FOR LNS-BASED LONWORKS SYSTEMS</u>		
This checklist is not all-inclusive of the requirements of this specification and should not be interpreted as such. Instructions: Initial each item in the space provided (____) verifying that the requirement has been met.		
This checklist is for (circle one:) Pre-Construction QC Checklist Submittal Post-Construction QC Checklist Submittal Close-out QC Checklist Submittal		
Items verified for Pre-Construction, Post-Construction and Closeout QC Checklist Submittals:		
1	All DDC Hardware is numbered on Control System Schematic Drawings.	____
2	Signal lines on Control System Schematic are labeled with the signal type.	____
3	Local Display Panel (LDP) Locations are shown on Control System Schematic drawings.	____
Items verified for Post-Construction and Closeout QC Checklist Submittals:		
4	All sequences are performed as specified using DDC Hardware.	____
5	Training schedule and course attendee list has been developed and coordinated with shops and submitted.	____
6	All DDC Hardware is installed on a TP/FT-10 Channel.	____
7	All Application Specific Controllers (ASCs) are LonMark certified.	____
8	Communication between DDC Hardware is only via CEA-709.1-D using SNVTs. Other protocols have not been used. Network variables other than SNVTs have not been used.	____
9	Explicit messaging has not been used.	____
10	Scheduling is performed in DDC Hardware meeting the Simple Schedule Functional Profile	____
Items verified for Closeout QC Checklist Submittal:		

<u>QC CHECKLIST FOR LNS-BASED LONWORKS SYSTEMS</u>		
11	Final As-built Drawings, including all Points Schedule drawings, accurately represent the final installed system.	____
12	Programming software has been submitted for all programmable controllers.	____
13	All software has been licensed to the Government.	
14	O&M Instructions have been completed and submitted.	____
15	Training course has been completed.	____
16	LonWorks Network Services (LNS) Database is up-to-date and accurately represents the final installed system.	____
17	LNS Plug-ins have been submitted for all Application Specific Controllers (ASCs).	____
18	Programming software has been submitted for all General Purpose Programmable Controllers (GPPCs) and all Application Generic Controllers (AGCs).	____
	(QC Representative Signature)	(Date)

<u>QC CHECKLIST FOR NIAGARA FRAMEWORK BASED LONWORKS SYSTEMS</u>		
This checklist is not all-inclusive of the requirements of this specification and should not be interpreted as such. Instructions: Initial each item in the space provided (____) verifying that the requirement has been met.		
This checklist is for (circle one:) Pre-Construction QC Checklist Submittal Post-Construction QC Checklist Submittal Close-out QC Checklist Submittal		
Items verified for Pre-Construction, Post-Construction and Closeout QC Checklist Submittals:		
1	All DDC Hardware is numbered on Control System Schematic Drawings.	____

<u>QC CHECKLIST FOR NIAGARA FRAMEWORK BASED LONWORKS SYSTEMS</u>		
2	Signal lines on Control System Schematic are labeled with the signal type.	____
3	Local Display Panel (LDP) Locations are shown on Control System Schematic drawings.	____
Items verified for Post-Construction and Closeout QC Checklist Submittals:		
4	All sequences are performed as specified using DDC Hardware.	____
5	Training schedule and course attendee list has been developed and coordinated with shops and submitted.	____
6	All DDC Hardware except Niagara Framework Supervisory Gateways is installed on a TP/FT-10 Channel.	____
7	All Application Specific Controllers (ASCs) are LonMark certified.	____
8	Except for communication between two Niagara Framework Supervisory Gateways, Communication between DDC Hardware is only via CEA-709.1-D using SNVTs. Other protocols have not been used. Network variables other than SNVTs have not been used. Communication between Niagara Framework Supervisory Gateways is via Fox Protocol.	____
9	Explicit messaging has not been used.	____
10	Scheduling, Alarming, and Trending have been implemented using Niagara Framework objects and services.	____
Items verified for Closeout QC Checklist Submittal:		
11	Final As-built Drawings, including all Points Schedule drawings, accurately represent the final installed system.	____
12	Programming software has been submitted for all programmable controllers.	____
13	All software has been licensed to the Government.	____
14	O&M Instructions have been completed and submitted.	____
15	Training course has been completed.	____
16	The database in each Niagara Framework Supervisory Gateway is up-to-date and accurately represents the building control network beneath that Niagara Framework Supervisory Gateway.	____
17	Niagara Wizards have been submitted for all Application Specific Controllers (ASCs) for which a Wizard is available and for all Application Generic Controllers (AGCs).	____

<u>QC CHECKLIST FOR NIAGARA FRAMEWORK BASED LONWORKS SYSTEMS</u>		
18	Programming software has been submitted for all General Purpose Programmable Controllers (GPPCs) and all Application Generic Controllers (AGCs).	____
	(QC Representative Signature)	(Date)

<u>QC CHECKLIST FOR BACNET SYSTEMS</u>		
This checklist is not all-inclusive of the requirements of this specification and should not be interpreted as such. Instructions: Initial each item in the space provided (____) verifying that the requirement has been met.		
This checklist is for (circle one:) Pre-Construction QC Checklist Submittal Post-Construction QC Checklist Submittal Close-out QC Checklist Submittal		
Items verified for Pre-Construction, Post-Construction and Closeout QC Checklist Submittals:		
1	All DDC Hardware is numbered on Control System Schematic Drawings.	____
2	Signal lines on Control System Schematic are labeled with the signal type.	____
3	Local Display Panel (LDP) Locations are shown on Control System Schematic drawings.	____
Items verified for Post-Construction and Closeout QC Checklist Submittals:		
4	All sequences are performed as specified using DDC Hardware.	____
5	Training schedule and course attendee list has been developed and coordinated with shops and submitted.	____
Items verified for Closeout QC Checklist Submittal:		

<u>QC CHECKLIST FOR BACNET SYSTEMS</u>		
6	Final As-built Drawings, including all Points Schedule drawings, accurately represent the final installed system.	____
7	Programming software has been submitted for all programmable controllers.	____
8	All software has been licensed to the Government.	
9	O&M Instructions have been completed and submitted.	____
10	Training course has been completed.	____
11	All DDC Hardware is installed on a BACnet ASHRAE 135 network using either MS/TP in accordance with Clause 9 or IP in accordance with Annex J.	____
12	All DDC Hardware is BTL listed.	____
13	Communication between DDC Hardware is only via BACnet using standard services, except as specifically permitted by the specification. Non-standard services have been fully documented in the DDC Hardware Schedule.	____
14	Scheduling, Alarming, and Trending have been implemented using the standard BACnet Objects for these functions.	____
15	All Properties indicated as required to be Writable are Writable and Overrides have been provided as indicated	____
	(QC Representative Signature)	(Date)

<u>QC CHECKLIST FOR NIAGARA FRAMEWORK BASED BACNET SYSTEMS</u>
This checklist is not all-inclusive of the requirements of this specification and should not be interpreted as such. Instructions: Initial each item in the space provided (____) verifying that the requirement has been met.
This checklist is for (circle one:) Pre-Construction QC Checklist Submittal Post-Construction QC Checklist Submittal Close-out QC Checklist Submittal

<u>QC CHECKLIST FOR NIAGARA FRAMEWORK BASED BACNET SYSTEMS</u>		
Items verified for Pre-Construction, Post-Construction and Closeout QC Checklist Submittals:		
1	All DDC Hardware is numbered on Control System Schematic Drawings.	____
2	Signal lines on Control System Schematic are labeled with the signal type.	____
3	Local Display Panel (LDP) Locations are shown on Control System Schematic drawings.	____
Items verified for Post-Construction and Closeout QC Checklist Submittals:		
4	All sequences are performed as specified using DDC Hardware.	____
5	Training schedule and course attendee list has been developed and coordinated with shops and submitted.	____
Items verified for Closeout QC Checklist Submittal:		
6	Final As-built Drawings, including all Points Schedule drawings, accurately represent the final installed system.	____
7	Programming software has been submitted for all programmable controllers.	____
8	All software has been licensed to the Government.	____
9	O&M Instructions have been completed and submitted.	____
10	Training course has been completed.	____
11	All DDC Hardware is installed on a BACnet ASHRAE 135 network using either MS/TP in accordance with Clause 9 or IP in accordance with Annex J.	____
12	All DDC Hardware is BTL listed.	____
13	Communication between DDC Hardware is only via BACnet using standard services, except as specifically permitted by the specification. Non-standard services have been fully documented in the DDC Hardware Schedule.	____
14	Scheduling, Alarming, and Trending have been implemented using Niagara Framework objects and services, and BACnet Intrinsic Alarming as indicated.	____
15	All Properties indicated as required to be Writable are Writable and Overrides have been provided as indicated	____

<u>QC CHECKLIST FOR NIAGARA FRAMEWORK BASED BACNET SYSTEMS</u>	
(QC Representative Signature)	(Date)

-- End of Section --

SECTION 23 09 13

INSTRUMENTATION AND CONTROL DEVICES FOR HVAC
11/15, CHG 2: 05/21

PART 1 GENERAL

1.1 SUMMARY

This section provides for the instrumentation control system components excluding direct digital controllers, network controllers, gateways etc. that are necessary for a completely functional automatic control system. When combined with a Direct Digital Control (DDC) system, the Instrumentation and Control Devices covered under this section must be a complete system suitable for the control of the heating, ventilating and air conditioning (HVAC) and other building-level systems as specified and indicated.

- a. Install hardware to perform the control sequences as specified and indicated and to provide control of the equipment as specified and indicated.
- b. Install hardware such that individual control equipment can be replaced by similar control equipment from other equipment manufacturers with no loss of system functionality.
- c. Install and configure hardware such that the Government or their agents are able to perform repair, replacement, and upgrades of individual hardware without further interaction with the installing Contractor.

1.1.1 Verification of Dimensions

After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing any work.

1.1.2 Drawings

The Government will not indicate all offsets, fittings, and accessories that may be required on the drawings. Carefully investigate the mechanical, electrical, and finish conditions that could affect the work to be performed, arrange such work accordingly, and provide all work necessary to meet such conditions.

1.2 RELATED SECTIONS

Related work specified elsewhere.

Section 01 30 00 ADMINISTRATIVE REQUIREMENTS

Section 23 30 00 HVAC AIR DISTRIBUTION

Section 23 05 15 COMMON PIPING FOR HVAC

Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC

Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM

1.3 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL, INC. (AMCA)

- AMCA 500-D (2018) Laboratory Methods of Testing
Dampers for Rating
- AMCA 511 (2010; R 2016) Certified Ratings Program
for Air Control Devices

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

- ANSI C12.1 (2014; Errata 2016) Electric Meters - Code
for Electricity Metering

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

- ASME B16.15 (2018) Cast Copper Alloy Threaded Fittings
Classes 125 and 250
- ASME B16.18 (2021) Cast Copper Alloy Solder Joint
Pressure Fittings
- ASME B16.22 (2021) Wrought Copper and Copper Alloy
Solder Joint Pressure Fittings
- ASME B16.26 (2018) Standard for Cast Copper Alloy
Fittings for Flared Copper Tubes
- ASME B16.34 (2021) Valves - Flanged, Threaded and
Welding End
- ASME B40.100 (2013) Pressure Gauges and Gauge
Attachments

ASTM INTERNATIONAL (ASTM)

- ASTM A269/A269M (2015; R 2019) Standard Specification for
Seamless and Welded Austenitic Stainless
Steel Tubing for General Service
- ASTM A536 (1984; R 2019; E 2019) Standard
Specification for Ductile Iron Castings
- ASTM B32 (2020) Standard Specification for Solder
Metal
- ASTM B75/B75M (2020) Standard Specification for Seamless
Copper Tube
- ASTM B88 (2022) Standard Specification for Seamless
Copper Water Tube
- ASTM D635 (2018) Standard Test Method for Rate of

Burning and/or Extent and Time of Burning
of Plastics in a Horizontal Position

ASTM D1693

(2015) Standard Test Method for
Environmental Stress-Cracking of Ethylene
Plastics

FLUID CONTROLS INSTITUTE (FCI)

FCI 70-2

(2021) Control Valve Seat Leakage

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 142

(2007; Errata 2014) Recommended Practice
for Grounding of Industrial and Commercial
Power Systems - IEEE Green Book

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI C12.20

(2015; E 2018) Electricity Meters - 0.1,
0.2, and 0.5 Accuracy Classes

NEMA/ANSI C12.10

(2011; R 2021) Physical Aspects of
Watt-hour Meters - Safety Standard

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70

(2023) National Electrical Code

NFPA 90A

(2021) Standard for the Installation of
Air Conditioning and Ventilating Systems

UNDERWRITERS LABORATORIES (UL)

UL 94

(2013; Reprint Apr 2022) UL Standard for
Safety Tests for Flammability of Plastic
Materials for Parts in Devices and
Appliances

UL 555

(2006; Reprint Aug 2016) UL Standard for
Safety Fire Dampers

UL 555S

(2014; Reprint Oct 2020) UL Standard for
Safety Smoke Dampers

UL 5085-3

(2006; Reprint Jan 2022) UL Standard for
Safety Low Voltage Transformers - Part 3:
Class 2 and Class 3 Transformers

1.4 SUBMITTALS

Submittal requirements are specified in Section 23 09 00 INSTRUMENTATION
AND CONTROL FOR HVAC.

1.5 DELIVERY AND STORAGE

Store and protect products from the weather, humidity, and temperature
variations, dirt and dust, and other contaminants, within the storage
condition limits published by the equipment manufacturer.

1.6 INPUT MEASUREMENT ACCURACY

Select, install and configure sensors, transmitters and DDC Hardware such that the maximum error of the measured value at the input of the DDC hardware is less than the maximum allowable error specified for the sensor or instrumentation.

1.7 SUBCONTRACTOR SPECIAL REQUIREMENTS

Perform all work in this section in accordance with the paragraph entitled CONTRACTOR SPECIAL REQUIREMENTS in Section 01 30 00 ADMINISTRATIVE REQUIREMENTS.

PART 2 PRODUCTS

2.1 EQUIPMENT

2.1.1 General Requirements

All products used to meet this specification must meet the indicated requirements, but not all products specified here will be required by every project. All products must meet the requirements both Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC and this Section.

2.1.2 Operation Environment Requirements

Unless otherwise specified, provide products rated for continuous operation under the following conditions:

2.1.2.1 Pressure

Pressure conditions normally encountered in the installed location.

2.1.2.2 Vibration

Vibration conditions normally encountered in the installed location.

2.1.2.3 Temperature

- a. Products installed indoors: Ambient temperatures in the range of 32 to 112 degrees F and temperature conditions outside this range normally encountered at the installed location.
- b. Products installed outdoors or in unconditioned indoor spaces: Ambient temperatures in the range of -35 to +151 degrees F and temperature conditions outside this range normally encountered at the installed location.

2.1.2.4 Humidity

10 to 95 percent relative humidity, non-condensing and also humidity conditions outside this range normally encountered at the installed location.

2.2 WEATHERSHIELDS

Provide weathershields constructed of galvanized steel painted white,

unpainted aluminum, aluminum painted white, or white PVC.

2.3 TUBING

2.3.1 Copper

Provide [ASTM B75/B75M](#) or [ASTM B88](#) rated tubing meeting the following requirements:

- a. For tubing [0.375 inch](#) outside diameter and larger provide tubing with minimum wall thickness equal to [ASTM B88](#), Type M
- b. For tubing less than [0.375 inch](#) outside diameter provide tubing with minimum wall thickness of [0.025 inch](#)
- c. For exposed tubing and tubing for working pressures greater than [30 psig](#) provide hard copper tubing.
- d. Provide fittings which are [ASME B16.18](#) or [ASME B16.22](#) solder type using [ASTM B32](#) 95-5 tin-antimony solder, or which are [ASME B16.26](#) compression type.

2.3.2 Stainless Steel

For stainless steel tubing provide tubing conforming to [ASTM A269/A269M](#)

2.3.3 Plastic

Provide plastic tubing with the burning characteristics of linear low-density polyethylene tubing which is self-extinguishing when tested in accordance with [ASTM D635](#), has [UL 94](#) V-2 flammability classification or better, and which withstands stress cracking when tested in accordance with [ASTM D1693](#). Provide plastic-tubing bundles with Mylar barrier and flame-retardant polyethylene jacket.

2.4 WIRE AND CABLE

Provide wire and cable meeting the requirements of [NFPA 70](#) and [NFPA 90A](#) in addition to the requirements of this specification and referenced specifications.

2.4.1 Terminal Blocks

For terminal blocks which are not integral to other equipment, provide terminal blocks which are insulated, modular, feed-through, clamp style with recessed captive screw-type clamping mechanism, suitable for DIN rail mounting, and which have enclosed sides or end plates and partition plates for separation.

2.4.2 Control Wiring for Binary Signals

For Control Wiring for Binary Signals, provide [18 AWG](#) copper or thicker wire rated for 300-volt service.

2.4.3 Control Wiring for Analog Signals

For Control Wiring for Analog Signals, provide [18 AWG](#) or thicker, copper, single- or multiple-twisted wire meeting the following requirements:

- a. minimum 2 inch lay of twist
- b. 100 percent shielded pairs
- c. at least 300-volt insulation
- d. each pair has a 20 AWG tinned-copper drain wire and individual overall pair insulation
- e. cables have an overall aluminum-polyester or tinned-copper cable-shield tape, overall 20 AWG tinned-copper cable drain wire, and overall cable insulation.

2.4.4 Power Wiring for Control Devices

For 24-volt circuits, provide insulated copper 18 AWG or thicker wire rated for 300 VAC service. For 120-volt circuits, provide 14 AWG or thicker stranded copper wire rated for 600-volt service.

2.4.5 Transformers

Provide UL 5085-3 approved transformers. Select transformers sized so that the connected load is no greater than 80 percent of the transformer rated capacity.

2.5 AUTOMATIC CONTROL VALVES

Provide valves with stainless-steel stems and stuffing boxes with extended necks to clear the piping insulation. Provide valves with bodies meeting ASME B16.34 or ASME B16.15 pressure and temperature class ratings based on the design operating temperature and 150 percent of the system design operating pressure. Unless otherwise specified or indicated, provide valves meeting FCI 70-2 Class III leakage rating. Provide valves rated for modulating or two-position service as indicated, which close against a differential pressure indicated as the Close-Off pressure and which are Normally-Open, Normally-Closed, or Fail-In-Last-Position as indicated.

2.5.1 Valve Type

2.5.1.1 Liquid Service 150 Degrees F or Less

Use either globe valves or ball valves except that butterfly valves may be used for sizes 4 inch and larger.

2.5.1.2 Liquid Service Above 150 Degrees F

- a. Two-position valves: Use either globe valves or ball valves except that butterfly valves may be used for sizes 4 inch and larger.
- b. Modulating valves: Use globe valves except that butterfly valves may be used for sizes 4 inch and larger.

2.5.2 Valve Flow Coefficient and Flow Characteristic

2.5.2.1 Two-Way Modulating Valves

Provide the valve coefficient (Cv) indicated. Provide equal-percentage flow characteristic for liquid service except for butterfly valves.

2.5.3 Two-Position Valves

Use full line size full port valves with maximum available (Cv).

2.5.4 Globe Valves

2.5.4.1 Liquid Service Not Exceeding 150 Degrees F

a. Valve body and body connections:

- (1) valves 1-1/2 inches and smaller: brass or bronze body, with threaded or union ends
- (2) valves from 2 inches to 3 inches inclusive: brass, bronze, or iron bodies. 2 inch valves with threaded connections; 2-1/2 to 3 inches valves with flanged connections

b. Internal valve trim: Brass or bronze.

c. Stems: Stainless steel.

d. Provide valves compatible with a solution of 30 percent ethylene or propylene glycol.

2.5.4.2 Liquid Service Not Exceeding 250 Degrees F

a. Valve body and body connections:

- (1) valves 1-1/2 inches and smaller: brass or bronze body, with threaded or union ends

- (2) valves from 2 inches to 3 inches inclusive: brass, bronze, or iron bodies. 2 inch valves with threaded connections; 2-1/2 to 3 inches valves with flanged connections

b. Internal trim: Type 316 stainless steel including seats, seat rings, modulation plugs, valve stems, and springs.

c. Provide valves with non-metallic parts suitable for a minimum continuous operating temperature of 250 degrees F or 50 degrees F above the system design temperature, whichever is higher.

d. Provide valves compatible with a solution of 30 percent ethylene or propylene glycol

2.5.4.3 Hot water service 250 Degrees F and above

a. Provide valve bodies conforming to ASME B16.34 Class 300. For valves 1 inch and larger provide valves with bodies which are carbon steel, globe type with welded ends. For valves smaller than 1 inch provide valves with socket-weld ends. Provide valves with virgin polytetrafluoroethylene (PTFE) packing. Provide valve and actuator combinations which are normally closed.

b. Internal trim: Type 316 stainless steel including seats, seat rings, modulation plugs, valve stems, and springs.

2.5.5 Ball Valves

2.5.5.1 Liquid Service Not Exceeding 150 Degrees F

a. Valve body and connections:

(1) valves 1-1/2 inches and smaller: bodies of brass or bronze, with threaded or union ends

(2) valves from 2 inches to 3 inches inclusive: bodies of brass, bronze, or iron. 2 inch valves with threaded connections; valves from 2-1/2 to 3 inches with flanged connections.

b. Ball: Stainless steel or nickel-plated brass or chrome-plated brass.

c. Seals: Reinforced Teflon seals and EPDM O-rings.

d. Stem: Stainless steel, blow-out proof.

e. Provide valves compatible with a solution of 50 percent ethylene or propylene glycol.

2.5.6 Butterfly Valves

Provide butterfly valves which are threaded lug type suitable for dead-end service and modulation to the fully-closed position, with carbon-steel bodies or with ductile iron bodies in accordance with ASTM A536. Provide butterfly valves with non-corrosive discs, stainless steel shafts supported by bearings, and EPDM seats suitable for temperatures from -20 to +250 degrees F. Provide valves with rated Cv of the Cv at 70 percent (60 degrees) open position. Provide valves meeting FCI 70-2 Class VI leakage rating.

2.6 DAMPERS

2.6.1 Damper Assembly

Provide single damper sections with blades no longer than 48 inches and which are no higher than 72 inches and damper blade width of 8 inches or less. When larger sizes are required, combine damper sections. Provide dampers made of steel, or other materials where indicated and with assembly frames constructed of 0.07 inch minimum thickness stainless steel channels with mitered and welded corners. Steel channel frames constructed of 0.06 inch minimum thickness are acceptable provided the corners are reinforced.

a. Flat blades must be made rigid by folding the edges. Blade-operating linkages must be within the frame so that blade-connecting devices within the same damper section must not be located directly in the air stream.

b. Damper axles must be 1/2 inch minimum, plated steel rods supported in the damper frame by stainless steel or bronze bearings. Blades mounted vertically must be supported by thrust bearings.

c. Provide dampers which do not exceed a pressure drop through the damper of 0.04 inches water gauge at 1000 ft/min in the wide-open position. Provide dampers with frames not less than 2 inch in width. Provide dampers which have been tested in accordance with AMCA 500-D.

2.6.2 Operating Linkages

For operating links external to dampers, such as crank arms, connecting rods, and line shafting for transmitting motion from damper actuators to dampers, provide links able to withstand a load equal to at least 300 percent of the maximum required damper-operating force without deforming. Rod lengths must be adjustable. Links must be brass, bronze, zinc-coated steel, or stainless steel. Working parts of joints and clevises must be brass, bronze, or stainless steel. Adjustments of crank arms must control the open and closed positions of dampers.

2.6.3 Damper Types

2.6.3.1 Flow Control Dampers

Provide parallel-blade or opposed blade type dampers for outside air, return air, relief air, exhaust, face and bypass dampers as indicated on the Damper Schedule. Blades must have interlocking edges. The channel frames of the dampers must be provided with jamb seals to minimize air leakage. Unless otherwise indicated, dampers must meet [AMCA 511](#) Class 1 requirements. Outside air damper seals must be suitable for an operating temperature range of [-40 to +167 degrees F](#). Dampers must be rated at not less than [2000 ft/min](#) air velocity.

2.6.3.2 Mechanical Rooms and Other Utility Space Ventilation Dampers

Provide utility space ventilation dampers as indicated. Unless otherwise indicated provide [AMCA 511](#) class 3 dampers. Provide dampers rated at not less than [1500 ft/min](#) air velocity.

2.6.3.3 Smoke Dampers

Provide smoke-damper and actuator assemblies which meet the current requirements of [NFPA 90A](#), [UL 555](#), and [UL 555S](#). For combination fire and smoke dampers provide dampers rated for [250 degrees F](#) Class II leakage per [UL 555S](#).

2.7 SENSORS AND INSTRUMENTATION

Unless otherwise specified, provide sensors and instrumentation which incorporate an integral transmitter. Sensors and instrumentation, including their transmitters, must meet the specified accuracy and drift requirements at the input of the connected DDC Hardware's analog-to-digital conversion.

2.7.1 Analog and Binary Transmitters

Provide transmitters which match the characteristics of the sensor. Transmitters providing analog values must produce a linear 4-20 mAdc, 0-10 Vdc signal corresponding to the required operating range and must have zero and span adjustment. Transmitters providing binary values must have dry contacts rated at 1A at 24 Volts AC.

2.7.2 Network Transmitters

Sensors and Instrumentation incorporating an integral network connection are considered DDC Hardware and must meet the DDC Hardware requirements

BUILDING CONTROL SYSTEMS when used in a Lonworks network, or the requirements of 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS when used in a BACnet network.

2.7.3 Temperature Sensors

Provide the same sensor type throughout the project. Temperature sensors may be provided without transmitters. Where transmitters are used, the range must be the smallest available from the manufacturer and suitable for the application such that the range encompasses the expected range of temperatures to be measured. The end to end accuracy includes the combined effect of sensitivity, hysteresis, linearity and repeatability between the measured variable and the end user interface (graphic presentation) including transmitters if used.

2.7.3.1 Sensor Accuracy and Stability of Control

2.7.3.1.1 Conditioned Space Temperature

Plus or minus 0.5 degree F over the operating range.

2.7.3.1.2 Unconditioned Space Temperature

- a. Plus or minus 1 degree F over the range of 30 to 131 degrees F AND
- b. Plus or minus 4 degrees F over the rest of the operating range.

2.7.3.1.3 Duct Temperature

Plus or minus 0.5 degree F

2.7.3.1.4 Outside Air Temperature

- a. Plus or minus 2 degrees F over the range of -30 to +130 degrees F AND
- b. Plus or minus 1 degree F over the range of 30 to 130 degrees F.

2.7.3.1.5 High Temperature Hot Water

Plus or minus 3.6 degrees F.

2.7.3.1.6 Chilled Water

Plus or minus 0.8 degrees F over the range of 35 to 65 degrees F.

2.7.3.1.7 Dual Temperature Water

Plus or minus 2 degrees F.

2.7.3.1.8 Heating Hot Water

Plus or minus 2 degrees F.

2.7.3.1.9 Condenser Water

Plus or minus 2 degrees F.

2.7.3.2 Transmitter Drift

The maximum allowable transmitter drift: 0.25 degrees F per year.

2.7.3.3 Point Temperature Sensors

Point Sensors must be encapsulated in epoxy, series 300 stainless steel, anodized aluminum, or copper.

2.7.3.4 Temperature Sensor Details

2.7.3.4.1 Room Type

Provide the sensing element components within a decorative protective cover suitable for surrounding decor.

2.7.3.4.2 Duct Probe Type

Ensure the probe is long enough to properly sense the air stream temperature.

2.7.3.4.3 Duct Averaging Type

Continuous averaging sensors must be one foot in length for each 1 square foot of duct cross-sectional area, and a minimum length of 5 feet.

2.7.3.4.4 Pipe Immersion Type

For pipes with larger than 3 inch diameter, provide minimum 3 inch immersion. For pipes with less than 3 inch diameter, provide immersion at least half the diameter of the pipe. Provide each sensor with a corresponding pipe-mounted sensor well, unless indicated otherwise. Sensor wells must be stainless steel when used in steel piping, and brass when used in copper piping.

2.7.3.4.5 Outside Air Type

Provide the sensing element rated for outdoor use

2.7.4 Relative Humidity Sensor

Relative humidity sensors must use bulk polymer resistive or thin film capacitive type non-saturating sensing elements capable of withstanding a saturated condition without permanently affecting calibration or sustaining damage. The sensors must include removable protective membrane filters. Where required for exterior installation, sensors must be capable of surviving below freezing temperatures and direct contact with moisture without affecting sensor calibration. When used indoors, the sensor must be capable of being exposed to a condensing air stream (100 percent relative humidity) with no adverse effect to the sensor's calibration or other harm to the instrument. The sensor must be of the wall-mounted or duct-mounted type, as required by the application, and must be provided with any required accessories. Sensors used in duct high-limit applications must have a bulk polymer resistive sensing element. Duct-mounted sensors must be provided with a duct probe designed to protect the sensing element from dust accumulation and mechanical damage. Relative humidity (RH) sensors must measure relative humidity over a range of 0 percent to 100 percent with an accuracy of plus or minus 2 percent. RH sensors must function over a temperature range of 40 to 135

degrees F and must not drift more than 1 percent per year.

2.7.5 Carbon Dioxide (CO2) Sensors

Provide photometric type CO2 sensors with integral transducers and linear output. Carbon dioxide (CO2) sensors must measure CO2 concentrations between 0 to 2000 parts per million (ppm) using non-dispersible infrared (NDIR) technology with an accuracy of plus or minus 50 ppm and a maximum response time of 1 minute. The sensor must be rated for operation at ambient air temperatures within the range of 32 to 122 degrees F and relative humidity within the range of 20 to 95 percent (non-condensing). The sensor must have a maximum drift of 2 percent per year. The sensor chamber must be manufactured with a non-corrosive material that does not affect carbon dioxide sample concentration. Duct mounted sensors must be provided with a duct probe designed to protect the sensing element from dust accumulation and mechanical damage. The sensor must have a calibration interval no less than 5 years.

2.7.6 Differential Pressure Instrumentation

2.7.6.1 Differential Pressure Sensors

Provide Differential Pressure Sensors with ranges as indicated or as required for the application. Pressure sensor ranges must not exceed the high end range indicated on the Points Schedule by more than 50 percent. The over pressure rating must be a minimum of 150 percent of the highest design pressure of either input to the sensor. The accuracy must be plus or minus 1 percent of full scale. The sensor must have a maximum drift of 2 percent per year

2.7.6.2 Differential Pressure Switch

Provide differential pressure switches with a user-adjustable setpoint which are sized for the application such that the setpoint is between 25 percent and 75 percent of the full range. The over pressure rating must be a minimum of 150 percent of the highest design pressure of either input to the sensor. The switch must have two sets of contacts and each contact must have a rating greater than it's connected load. Contacts must open or close upon rise of pressure above the setpoint or drop of pressure below the setpoint as indicated.

2.7.7 Flow Sensors

2.7.7.1 Airflow Measurement Array (AFMA)

2.7.7.1.1 Airflow Straightener

Provide AFMAs which contain an airflow straightener if required by the AFMA manufacturer's published installation instructions. The straightener must be contained inside a flanged sheet metal casing, with the AFMA located as specified according to the published recommendation of the AFMA manufacturer. In the absence of published documentation, provide airflow straighteners if there is any duct obstruction within 5 duct diameters upstream of the AFMA. Air-flow straighteners, where required, must be constructed of 0.125 inch aluminum honeycomb and the depth of the straightener must not be less than 1.5 inches.

2.7.7.1.2 Resistance to Airflow

The resistance to air flow through the AFMA, including the airflow straightener must not exceed 0.085 inch water gauge at an airflow of 2,000 fpm. AFMA construction must be suitable for operation at airflows of up to 5000 fpm over a temperature range of 40 to 120 degrees F.

2.7.7.1.3 Outside Air Temperature

In outside air measurement or in low-temperature air delivery applications, provide an AFMA certified by the manufacturer to be accurate as specified over a temperature range of -20 to +120 degrees F .

2.7.7.1.4 Pitot Tube AFMA

Each Pitot Tube AFMA must contain an array of velocity sensing elements. The velocity sensing elements must be of the multiple pitot tube type with averaging manifolds. The sensing elements must be distributed across the duct cross section in the quantity and pattern specified or recommended by the published installation instructions of the AFMA manufacturer.

- a. Pitot Tube AFMAs for use in airflows over 600 fpm must have an accuracy of plus or minus 5 percent over a range of 500 to 2500 fpm.
- b. Pitot Tube AFMAs for use in airflows under 600 fpm must have an accuracy of plus or minus 5 percent over a range of 125 to 2500 fpm.

2.7.7.1.5 Electronic AFMA

Each electronic AFMA must consist of an array of velocity sensing elements of the resistance temperature detector (RTD) or thermistor type. The sensing elements must be distributed across the duct cross section in the quantity and pattern specified or recommended by the published application data of the AFMA manufacturer. Electronic AFMAs must have an accuracy of plus or minus 5 percent over a range of 125 to 5,000 fpm and the output must be temperature compensated over a range of 32 to 212 degrees F.

2.7.7.1.6 Fan Inlet Measurement Devices

Fan inlet measurement devices cannot be used unless indicated on the drawings or schedules.

2.7.7.2 Orifice Plate

Orifice plate must be made of an austenitic stainless steel sheet of 0.125 inch nominal thickness with an accuracy of plus or minus 1 percent of full flow. The orifice plate must be flat within 0.002 inches. The orifice surface roughness must not exceed 20 micro-inches. The thickness of the cylindrical face of the orifice must not exceed 2 percent of the pipe inside diameter or 12.5 percent of the orifice diameter, whichever is smaller. The upstream edge of the orifice must be square and sharp. Where orifice plates are used, concentric orifice plates must be used in all applications except steam flow measurement in horizontal pipelines.

2.7.7.3 Flow Nozzle

Flow nozzle must be made of austenitic stainless steel with an accuracy of plus or minus 1 percent of full flow. The inlet nozzle form must be elliptical and the nozzle throat must be the quadrant of an ellipse. The

thickness of the nozzle wall and flange must be such that distortion of the nozzle throat from strains caused by the pipeline temperature and pressure, flange bolting, or other methods of installing the nozzle in the pipeline must not cause the accuracy to degrade beyond the specified limit. The outside diameter of the nozzle flange or the design of the flange facing must be such that the nozzle throat must be centered accurately in the pipe.

2.7.7.4 Insertion Magnetic Flow Meter

Provide insertion type magnetic flowmeters with all installation hardware necessary to enable insertion and removal of the meter without system shutdown. All parts must meet or exceed the pressure classification of the pipe system it is installed in. Flowmeter accuracy must be no greater than plus or minus 1 percent of rate from 2 to 20 feet/sec. Wetted material parts must be 300 series stainless steel. The flowmeter must include either dry contact pulse outputs, 4-20mA, 0-10Vdc or 0-5Vdc outputs.

2.7.7.5 Flow Switch

Flow switch must have a repetitive accuracy of plus or minus 10 percent of actual flow setting. Switch actuation must be adjustable over the operating flow range, and must be sized for the application such that the setpoint is between 25 percent and 75 percent of the full range.. The switch must have Form C snap-action contacts, rated for the application. The flow switch must have non flexible paddle with magnetically actuated contacts and be rated for service at a pressure greater than the installed conditions. Flow switch for use in sewage system must be rated for use in corrosive environments encountered.

2.7.7.6 Gas Flow Meter

Gas flow meter must be diaphragm or bellows type (gas positive displacement meters) for flows up to 2500 SCFH and axial flow turbine type for flows above 2500 SCFH, designed specifically for natural gas supply metering, and rated for the pressure, temperature, and flow rates of the installation. Meter must have a minimum turndown ratio of 10 to 1 with an accuracy of plus or minus 1 percent of actual flow rate. The meter index must include a direct reading mechanical totalizing register and electrical impulse dry contact output for remote monitoring. The electrical impulse dry contact output must not require field adjustment or calibration. The electrical impulse dry contact output must have a minimum resolution of 100 cubic feet of gas per pulse and must not exceed 15 pulses per second at the design flow.

2.7.8 Electrical Instruments

Provide Electrical Instruments with an input range as indicated or sized for the application. Unless otherwise specified, AC instrumentation must be suitable for 60 Hz operation.

2.7.8.1 Current Transducers

Current transducers must accept an AC current input and must have an accuracy of plus or minus 0.5 percent of full scale. The device must have a means for calibration. Current transducers for variable frequency applications must be rated for variable frequency operation.

2.7.8.2 Current Sensing Relays (CSRs)

Current sensing relays (CSRs) must provide a normally-open contact with a voltage and amperage rating greater than its connected load. Current sensing relays must be of split-core design. The CSR must be rated for operation at 200 percent of the connected load. Voltage isolation must be a minimum of 600 volts. The CSR must auto-calibrate to the connected load or be adjustable and field calibrated. Current sensors for variable frequency applications must be rated for variable frequency operation.

2.7.8.3 Voltage Transducers

Voltage transducers must accept an AC voltage input and have an accuracy of plus or minus 0.25 percent of full scale. The device must have a means for calibration. Line side fuses for transducer protection must be provided.

2.7.8.4 Energy Metering

2.7.8.4.1 Watt or Watthour Transducers

Watt transducers must measure voltage and current and must output kW or kWh or both kW and kWh as indicated. kW outputs must have an accuracy of plus or minus 0.5 percent over a power factor range of 0.1 to 1. kWh outputs must have an accuracy of plus or minus 0.5 percent over a power factor range of 0.1 to 1.

2.7.8.4.2 Watthour Revenue Meter (with and without Demand Register)

All Watthour revenue meters must measure voltage and current and must be in accordance with ANSI C12.1 with an ANSI C12.20 Accuracy class of 0.5 and must have pulse initiators for remote monitoring of Watthour consumption. Pulse initiators must consist of form C contacts with a current rating not to exceed two amperes and voltage not to exceed 500 V, with combinations of VA not to exceed 100 VA, and a life rating of one billion operations. Meter sockets must be in accordance with NEMA/ANSI C12.10. Watthour revenue meters with demand registers must output instantaneous demand in addition to the pulse initiators.

2.7.8.4.3 Steam Meters

Steam meters must be the vortex type, with pressure compensation, a minimum turndown ratio of 10 to 1, and an output signal compatible with the DDC system.

2.7.8.4.4 Hydronic BTU Meters

The BTU meter is to be supplied with wall mount hardware and be capable of being installed remote from the flow meter. The BTU meter must include an LCD display for local indication of energy rate and for display of parameters and settings during configuration. Each BTU meter must be factory configured for its specific application and be completely field configurable by the user via a front panel keypad (no special interface device or computer required). The unit must output Energy Rate, Energy Total, Flow Rate, Supply Temperature, and Return Temperature. An integral transmitter is to provide a linear analog or configurable pulse output signal representing the energy rate; and the signal must be compatible with building automation system DDC Hardware to which the output is connected.

2.7.9 Carbon Monoxide Analyzer

Carbon monoxide analyzer must consist of an infrared light source in a weather proof steel enclosure for duct or stack mounting. An optical detector/analyzer in a similar enclosure, suitable for duct or stack mounting must be provided. Both assemblies must include internal blower systems to keep optical windows free of dust and ash at all times. The third component of the analyzer must be the electronics cabinet. Automatic flue gas temperature compensation and manual/automatic zeroing devices must be provided. Unit must read parts per million (ppm) of carbon monoxide in the range of 200 to 1,000 to ppm and the response time must be less than 3 seconds to 90 percent value. Unit measurement range must not exceed specified range by more than 50 percent. Repeatability must be plus or minus 1 percent of full scale with an accuracy of plus or minus 1 percent of full scale.

2.7.10 Occupancy Sensors

Occupancy sensors must have occupancy-sensing sensitivity adjustment and an adjustable off-delay timer with a setpoint of 15 minutes. Adjustments accessible from the face of the unit are preferred. Occupancy sensors must be rated for operation in ambient air temperatures ranging from 40 to 95 degrees F or temperatures normally encountered in the installed location. Sensors integral to wall mount on-off light switches must have an auto-off switch. Wall switch sensors must be decorator style and must fit behind a standard decorator type wall plate. All occupancy sensors, power packs, and slave packs must be UL listed. In addition to any outputs required for lighting control, the occupancy sensor must provide an output for the HVAC control system.

2.7.10.1 Passive Infrared (PIR) Occupancy Sensors

PIR occupancy sensors must have a multi-level, multi-segmented viewing lens and a conical field of view with a viewing angle of 180 degrees and a detection of at least 20 feet unless otherwise indicated or specified. PIR Sensors must provide field-adjustable background light-level adjustment with an adjustment range suitable to the light level in the sensed area, room or space. PIR sensors must be immune to false triggering from RFI and EMI.

2.7.10.2 Ultrasonic Occupancy Sensors

Ultrasonic sensors must operate at a minimum frequency 32 kHz and must be designed to not interfere with hearing aids.

2.7.10.3 Dual-Technology Occupancy Sensor (PIR and Ultrasonic)

Dual-Technology Occupancy Sensors must meet the requirements of both PIR and Ultrasonic Occupancy Sensors.

2.7.11 Vibration Switch

Vibration switch must be solid state, enclosed in a NEMA 250 Type 4 or Type 4X housing with sealed wire entry. Unit must have two independent sets of Form C switch contacts with one set to shutdown equipment upon excessive vibration and a second set for monitoring alarm level vibration. The vibration sensing range must be a true rms reading, suitable for the application. The unit must include either displacement

response for low speed or velocity response for high speed application. The frequency range must be at least 3 Hz to 500 Hz. Contact time delay must be 3 seconds. The unit must have independent start-up and running delay on each switch contact. Alarm limits must be adjustable and setpoint accuracy must be plus or minus 10 percent of setting with repeatability of plus or minus 2 percent.

2.7.12 Conductivity Sensor

Sensor must include local indicating meter and must be suitable for measurement of conductivity of water in boilers, chilled water systems, condenser water systems, distillation systems, or potable water systems as indicated. Sensor must sense from 0 to 10 microSeimens per centimeter ($\mu\text{S}/\text{cm}$) for distillation systems, 0 to 100 $\mu\text{S}/\text{cm}$ for boiler, chilled water, and potable water systems and 0 to 1000 $\mu\text{S}/\text{cm}$ for condenser water systems. Contractor must field verify the ranges for particular applications and adjust the range as required. The output must be temperature compensated over a range of 32 to 212 degrees F. The accuracy must be plus or minus 2 percent of the full scale reading. Sensor must have automatic zeroing and must require no periodic maintenance or recalibration.

2.7.13 Temperature Switch

2.7.13.1 Duct Mount Temperature Low Limit Safety Switch (Freezestat)

Duct mount temperature low limit switches (Freezestats) must be manual reset, low temperature safety switches at least 1 foot long per square foot of coverage which must respond to the coldest 18 inch segment with an accuracy of plus or minus 3.6 degrees F. The switch must have a field-adjustable setpoint with a range of at least 30 to 50 degrees F. The switch must have two sets of contacts, and each contact must have a rating greater than its connected load. Contacts must open or close upon drop of temperature below setpoint as indicated and must remain in this state until reset.

2.7.13.2 Pipe Mount Temperature Limit Switch (AquaStat)

Pipe mount temperature limit switches (aquastats) must have a field adjustable setpoint between 60 and 90 degrees F, an accuracy of plus or minus 3.6 degrees F and a 10 degrees F fixed deadband. The switch must have two sets of contacts, and each contact must have a rating greater than its connected load. Contacts must open or close upon change of temperature above or below setpoint as indicated.

2.7.14 Damper End Switches

Each end switch must be a hermetically sealed switch with a trip lever and over-travel mechanism. The switch enclosure must be suitable for mounting on the duct exterior and must permit setting the position of the trip lever that actuates the switch. The trip lever must be aligned with the damper blade.

End switches integral to an electric damper actuator are allowed as long as at least one is adjustable over the travel of the actuator.

2.7.15 Air Quality Sensors

Provide full spectrum air quality sensors using a hot wire element based

on the Taguchi principle. The sensor must monitor a wide range of gaseous volatile organic components common in indoor air contaminants like paint fumes, solvents, cigarette smoke, and vehicle exhaust. The sensor must automatically compensate for temperature and humidity, have span and calibration potentiometers, operate on 24 VDC power with output of 0-10 VDC, and have a service rating of 32 to 140 degrees F and 5 to 95 percent relative humidity.

2.8 INDICATING DEVICES

All indicating devices must display readings in English (inch-pound) units.

2.8.1 Thermometers

Provide bi-metal type thermometers at locations indicated. Thermometers must have either 9 inch long scales or 3.5 inch diameter dials, with insertion, immersion, or averaging elements. Provide matching thermowells for pipe-mounted installations. Select scale ranges suitable for the intended service, with the normal operating temperature near the scale's midpoint. The thermometer's accuracy must be plus or minus 2 percent of the scale range.

2.8.1.1 Piping System Thermometers

Piping system thermometers must have brass, malleable iron or aluminum alloy case and frame, clear protective face, permanently stabilized glass tube with indicating-fluid column, white face, black numbers, and a 9 inch scale. Piping system thermometers must have an accuracy of plus or minus 1 percent of scale range. Thermometers for piping systems must have rigid stems with straight, angular, or inclined pattern. Thermometer stems must have expansion heads as required to prevent breakage at extreme temperatures. On rigid-stem thermometers, the space between bulb and stem must be filled with a heat-transfer medium.

2.8.1.2 Air-Duct Thermometers

Air-duct thermometers must have perforated stem guards and 45-degree adjustable duct flanges with locking mechanism.

2.8.2 Pressure Gauges

Provide pipe-mounted pressure gauges at the locations indicated. Gauges must conform to ASME B40.100 and have a 4 inch diameter dial and shutoff cock. Select scale ranges suitable for the intended service, with the normal operating pressure near the scale's midpoint. The gauge's accuracy must be plus or minus 2 percent of the scale range.

Gauges must be suitable for field or panel mounting as required, must have black legend on white background, and must have a pointer traveling through a 270-degree arc. Gauge range must be suitable for the application with an upper end of the range not to exceed 150 percent of the design upper limit. Accuracy must be plus or minus 3 percent of scale range. Gauges must meet requirements of ASME B40.100.

2.8.3 Low Differential Pressure Gauges

Gauges for low differential pressure measurements must be a minimum of 3.5 inch (nominal) size with two sets of pressure taps, and must have a diaphragm-actuated pointer, white dial with black figures, and pointer

zero adjustment. Gauge range must be suitable for the application with an upper end of the range not to exceed 150 percent of the design upper limit. Accuracy must be plus or minus two percent of scale range.

2.9 OUTPUT DEVICES

2.9.1 Actuators

Actuators must be electric (electronic) . All actuators must be normally open (NO), normally closed (NC) or fail-in-last-position (FILP) as indicated. Normally open and normally closed actuators must be of mechanical spring return type. Electric actuators must have an electronic cut off or other means to provide burnout protection if stalled. Actuators must have a visible position indicator. Electric actuators must provide position feedback to the controller as indicated. Actuators must smoothly and fully open or close the devices to which they are applied. Electric actuators must have a full stroke response time in both directions of 90 seconds or less at rated load. Electric actuators must be of the foot-mounted type with an oil-immersed gear train or the direct-coupled type. Where multiple electric actuators operate from a common signal, the actuators must provide an output signal identical to its input signal to the additional devices. All actuators must be rated for their operating environment. Actuators used outdoors must be designed and rated for outdoor use. Actuators under continuous exposure to water, such as those used in sumps, must be submersible.

Actuators incorporating an integral network connection are considered DDC Hardware and must meet the DDC Hardware requirements of Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS.

2.9.1.1 Valve Actuators

Valve actuators must provide shutoff pressures and torques as indicated on the Valve Schedule.

2.9.1.2 Damper Actuators

Damper actuators must provide the torque necessary per damper manufacturer's instructions to modulate the dampers smoothly over its full range of operation and torque must be at least 6 inch-pounds/1 square foot of damper area for opposed blade dampers and 9 inch-pounds/1 square foot of damper area for parallel blade dampers.

2.9.1.3 Electric Actuators

Each actuator must have distinct markings indicating the full-open and full-closed position. Each actuator must deliver the torque required for continuous uniform motion and must have internal end switches to limit the travel, or be capable of withstanding continuous stalling without damage. Actuators must function properly within 85 to 110 percent of rated line voltage. Provide actuators with hardened steel running shafts and gears of steel or copper alloy. Fiber or reinforced nylon gears may be used for torques less than 16 inch-pounds..

- a. Two-position actuators must be single direction, spring return, or reversing type. Two position actuator signals may either be the control power voltage or line voltage as needed for torque or appropriate interlock circuits.

- b. Modulating actuators must be capable of stopping at any point in the cycle, and starting in either direction from any point. Actuators must be equipped with a switch for reversing direction, and a button to disengage the clutch to allow manual adjustments. Provide the actuator with a hand crank for manual adjustments, as applicable. Modulating actuator input signals can either be a 4 to 20 mA_{dc} or a 0-10 VDC signal.
- c. Floating or pulse width modulation actuators are acceptable for non-fail safe applications unless indicated otherwise provided that the floating point control (timed actuation) must have a scheduled re-calibration of span and position no more than once a day and no less than once a week. The schedule for the re-calibration should not affect occupied conditions and be staggered between equipment to prevent falsely loading or unloading central plant equipment.

2.9.2 Relays

Relays must have contacts rated for the intended application, indicator light, and dust proof enclosure. The indicator light must be lit when the coil is energized and off when coil is not energized.

Control relay contacts must have utilization category and ratings selected for the application. Each set of contacts must incorporate a normally open (NO), normally closed (NC) and common contact. Relays must be rated for a minimum life of one million operations.

2.10 USER INPUT DEVICES

User Input Devices, including potentiometers, switches and momentary contact push-buttons. Potentiometers must be of the thumb wheel or sliding bar type. Momentary Contact Push-Buttons may include an adjustable timer for their output. User input devices must be labeled for their function.

2.11 MULTIFUNCTION DEVICES

Multifunction devices are products which combine the functions of multiple sensor, user input or output devices into a single product. Unless otherwise specified, the multifunction device must meet all requirements of each component device. Where the requirements for the component devices conflict, the multifunction device must meet the most stringent of the requirements.

2.11.1 Current Sensing Relay Command Switch

The Current Sensing Relay portion must meet all requirements of the Current Sensing Relay input device. The Command Switch portion must meet all requirements of the Relay output device except that it must have at least one normally-open (NO) contact.

Current Sensing Relays used for Variable Frequency Drives must be rated for Variable Frequency applications unless installed on the source side of the drive. If used in this situation, the threshold for showing status must be set to allow for the VFD's control power when the drive is not enabled and provide indication of operation when the drive is enabled at minimum speed.

2.11.2 Space Sensor Module

Space Sensor Modules must be multifunction devices incorporating a temperature sensor and one or more of the following as specified and indicated on the Space Sensor Module Schedule:

- a. A temperature indicating device.
- b. A User Input Device which must adjust a temperature setpoint output.
- c. A User Input Momentary Contact Button and an output to the control system indicating zone occupancy.
- d. A three position User Input Switch labeled to indicate heating, cooling and off positions ('HEAT-COOL-OFF' switch) and providing corresponding outputs to the control system.
- e. A two position User Input Switch labeled with 'AUTO' and 'ON' positions and providing corresponding output to the control system..
- f. A multi-position User Input Switch with 'OFF' and at least two fan speed positions and providing corresponding outputs to the control system.

Space Sensor Modules cannot contain mercury (Hg).

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 General Installation Requirements

Perform the installation under the supervision of competent technicians regularly employed in the installation of DDC systems.

3.1.1.1 Device Mounting Criteria

All devices must be installed in accordance with manufacturer's recommendations and as specified and indicated. Control devices to be installed in piping and ductwork must be provided with required gaskets, flanges, thermal compounds, insulation, piping, fittings, and manual valves for shutoff, equalization, purging, and calibration. Strap-on temperature sensing elements must not be used except as specified. Spare thermowells must be installed adjacent to each thermowell containing a sensor and as indicated. Devices located outdoors must have a weathershield.

3.1.1.2 Labels and Tags

Match labels and tags to the unique identifiers indicated on the As-Built drawings. Label all enclosures and instrumentation. Tag all sensors and actuators in mechanical rooms. Tag airflow measurement arrays to show flow rate range for signal output range, duct size, and pitot tube AFMA flow coefficient. Tag duct static pressure taps at the location of the pressure tap. Provide plastic or metal tags, mechanically attached directly to each device or attached by a metal chain or wire. Labels exterior to protective enclosures must be engraved plastic and mechanically attached to the enclosure or instrumentation. Labels inside protective enclosures may attached using adhesive, but must not be hand

written.

3.1.2 Weathershield

Provide weathershields for sensors located outdoors. Install weathershields such that they prevent the sun from directly striking the sensor and prevent rain from directly striking or dripping onto the sensor. Install weather shields with adequate ventilation so that the sensing element responds to the ambient conditions of the surroundings. When installing weathershields near outside air intake ducts, install them such that normal outside air flow does not cause rainwater to strike the sensor.

3.1.3 Room Instrument Mounting

Mount room instruments, including but not limited to wall mounted non-adjustable space sensor modules and sensors located in occupied spaces, 48 inches above the floor unless otherwise indicated. Install adjustable devices to be ADA compliant unless otherwise indicated on the Room Sensor Schedule:

- a. Space Sensor Modules for Fan Coil Units may be either unit or wall mounted but not mounted on an exterior wall.
- b. Wall mount all other Space Sensor Modules.

3.1.4 Indication Devices Installed in Piping and Liquid Systems

Provide snubbers for gauges in piping systems subject to pulsation. For gauges for steam service use pigtail fittings with cock. Install thermometers and temperature sensing elements in liquid systems in thermowells. Provide spare Pressure/Temperature Ports (Pete's Plug) for all temperature and pressure sensing elements installed in liquid systems for calibration/testing.

3.1.5 Occupancy Sensors

Provide a sufficient quantity of occupancy sensors to provide complete coverage of the area (room or space). Occupancy sensors are to be ceiling mounted. Install occupancy sensors in accordance with NFPA 70 requirements and the manufacturer's instructions. Do not locate occupancy sensors within 6 feet of HVAC outlets or heating ducts, or where they can "see" beyond any doorway. Installation above doorway(s) is preferred. Do not use ultrasonic sensors in spaces containing ceiling fans. Install sensors to detect motion to within 2 feet of all room entrances and to not trigger due to motion outside the room. Set the off-delay timer to 15 minutes unless otherwise indicated. Adjust sensors prior to beneficial occupancy, but after installation of furniture systems, shelving, partitions, etc. For each controlled area, provide one hundred percent coverage capable of detecting small hand-motion movements, accommodating all occupancy habits of single or multiple occupants at any location within the controlled room.

3.1.6 Switches

3.1.6.1 Temperature Limit Switch

Provide a temperature limit switch (freezestat) to sense the temperature at the location indicated. Provide a sufficient number of temperature

limit switches (freezestat) to provide complete coverage of the duct section but no less than 1 foot in length per square foot of cross sectional area. Install manual reset limit switches in approved, accessible locations where they can be reset easily. Install temperature limit switch (freezestat) sensing elements in a side-to-side (not top-to-bottom) serpentine pattern with the relay section at the highest point and in accordance with the manufacturer's installation instructions.

3.1.6.2 Hand-Off Auto Switches

Wire safety controls such as smoke detectors and freeze protection thermostats to protect the equipment during both hand and auto operation.

3.1.7 Temperature Sensors

Install temperature sensors in locations that are accessible and provide a good representation of sensed media. Installations in dead spaces are not acceptable. Calibrate and install sensors according to manufacturer's instructions. Select sensors only for intended application as designated or recommended by manufacturer.

3.1.7.1 Room Temperature Sensors

Mount the sensors on interior walls to sense the average room temperature at the locations indicated. Avoid locations near heat sources such as copy machines or locations by supply air outlet drafts. Mount the center of all user-adjustable sensors 48 inches above the floor to meet ADA requirements. Non user-adjustable sensors can be mounted as indicated in paragraph ROOM INSTRUMENT MOUNTING.

3.1.7.2 Duct Temperature Sensors

3.1.7.2.1 Probe Type

Place tip of the sensor in the middle of the airstream or in accordance with manufacturer's recommendations or instructions. Provide a gasket between the sensor housing and the duct wall. Seal the duct penetration air tight. When installed in insulated duct, provide enclosure or stand off fitting to accommodate the thickness of duct insulation to allow for maintenance or replacement of the sensor and wiring terminations. Seal the duct insulation penetration vapor tight.

3.1.7.2.2 Averaging Type

Weave the sensing element in a serpentine fashion from side to side perpendicular to the flow, across the duct or air handler cross-section, using durable non-metal supports in accordance with manufacturer's installation instructions. Avoid tight radius bends or kinking of the sensing element. Prevent contact between the sensing element and the duct or air handler internals. Provide a duct access door at the sensor location. The access door must be hinged on the side, factory insulated, have cam type locks, and be as large as the duct will permit, maximum 18 by 18 inches. For sensors inside air handlers, the sensors must be fully accessible through the air handler's access doors without removing any of the air handler's internals.

3.1.7.3 Immersion Temperature Sensors

Provide thermowells for sensors measuring piping, tank, or pressure vessel

temperatures. Locate wells to sense continuous flow conditions. Do not install wells using extension couplings. When installed on insulated piping, provide stand enclosure or stand off fitting to accommodate the thickness of the pipe insulation and allow for maintenance or replacement of the sensor or wiring terminations. Where piping diameters are smaller than the length of the wells, provide wells in piping at elbows to sense flow across entire area of well. Wells must not restrict flow area to less than 70 percent of pipe area. Increase piping size as required to avoid restriction. Provide the sensor well with a heat-sensitive transfer agent between the sensor and the well interior ensuring contact between the sensor and the well.

3.1.7.4 Outside Air Temperature Sensors

Provide outside air temperature sensors on the building's north side with a protective weather shade that does not inhibit free air flow across the sensing element, and protects the sensor from snow, ice, and rain. Location must not be near exhaust hoods and other areas such that it is not influenced by radiation or convection sources which may affect the reading. Provide a shield to shade the sensor from direct sunlight.

3.1.8 Air Flow Measurement Arrays (AFMA)

Locate Outside Air AFMAs downstream from the Outside Air filters.

Install AFMAs with the manufacturer's recommended minimum distances between upstream and downstream disturbances. Airflow straighteners may be used to reduce minimum distances as recommended by the AFMA manufacturer.

3.1.9 Duct Static Pressure Sensors

Locate the duct static pressure sensing tap at 75 percent of the distance between the first and last air terminal units. If the transmitter output is a 0-10Vdc signal, locate the transmitter in the same enclosure as the air handling unit (AHU) controller for the AHU serving the terminal units. If a remote duct static pressure sensor is to be used, run the signal wire back to the controller for the air handling unit.

3.1.10 Relative Humidity Sensors

Install relative humidity sensors in supply air ducts at least 10 feet downstream of humidity injection elements.

3.1.11 Meters

3.1.11.1 Flowmeters

Install flowmeters to ensure minimum straight unobstructed piping for at least 10 pipe diameters upstream and at least 5 pipe diameters downstream of the flowmeter, and in accordance with the manufacturer's installation instructions.

3.1.11.2 Energy Meters

Locate energy meters as indicated. Connect each meter output to the DDC system, to measure both instantaneous demand/energy and other variables as indicated.

3.1.12 Dampers

3.1.12.1 Damper Actuators

Provide spring return actuators which fail to a position that protects the served equipment and space on all control dampers related to freeze protection or force protection. For all outside, makeup and relief dampers provide dampers which fail closed. Terminal fan coil units, terminal VAV units, convectors, and unit heaters may be non-spring return unless indicated otherwise. Do not mount actuators in the air stream. Do not connect multiple actuators to a common drive shaft. Install actuators so that their action seal the damper to the extent required to maintain leakage at or below the specified rate and so that they move the blades smoothly throughout the full range of motion.

3.1.12.2 Damper Installation

Install dampers straight and true, level in all planes, and square in all dimensions. Dampers must move freely without undue stress due to twisting, racking (parallelogramming), bowing, or other installation error. External linkages must operate smoothly over the entire range of motion, without deformation or slipping of any connecting rods, joints or brackets that will prevent a return to it's normal position. Blades must close completely and leakage must not exceed that specified at the rated static pressure. Provide structural support for multi-section dampers. Acceptable methods of structural support include but are not limited to U-channel, angle iron, corner angles and bolts, bent galvanized steel stiffeners, sleeve attachments, braces, and building structure. Where multi-section dampers are installed in ducts or sleeves, they must not sag due to lack of support. Do not use jackshafts to link more than three damper sections. Do not use blade to blade linkages. Install outside and return air dampers such that their blades direct their respective air streams towards each other to provide for maximum mixing of air streams.

3.1.13 Valves

Install the valves in accordance with the manufacturer's instructions.

3.1.13.1 Valve Actuators

Provide spring return actuators on all control valves where freeze protection is required. Spring return actuators for terminal fan coil units, terminal VAV units, convectors, and unit heaters are not required unless indicated otherwise.

3.1.14 Thermometers and Gauges

3.1.14.1 Thermometers

Mount devices to allow reading while standing on the floor or ground, as applicable.

3.1.15 Wire and Cable

Provide complete electrical wiring for the Control System, including wiring to transformer primaries. Wire and Cable must be installed without splices between control devices and in accordance with NFPA 70 and NFPA 90A. Instrumentation grounding must be installed per the device manufacturer's instructions and as necessary to prevent ground loops, noise, and surges

from adversely affecting operation of the system. Test installed ground rods as specified in IEEE 142. Cables and conductor wires must be tagged at both ends, with the identifier indicated on the shop drawings. Electrical work must be as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM and as indicated. Wiring external to enclosures must be run in raceways, except low-voltage control and low-voltage network wiring may be installed as follows:

- a. plenum rated cable in suspended ceilings over occupied spaces may be run without raceways
- b. nonmetallic-sheathed cables or metallic-armored cables may be installed as permitted by NFPA 70.

Install control circuit wiring not in raceways in a neat and safe manner. Wiring must not use the suspended ceiling system (including tiles, frames or hangers) for support. Where conduit or raceways are required, control circuit wiring must not run in the same conduit/raceway as power wiring over 50 volts. Run all circuits over 50 volts in conduit, metallic tubing, covered metal raceways, or armored cable.

3.1.16 Copper Tubing

Provide hard-drawn copper tubing in exposed areas and either hard-drawn or annealed copper tubing in concealed areas. Use only tool-made bends. Use only brass or copper solder joint type fittings, except for connections to apparatus. For connections to apparatus use brass compression type fittings.

-- End of Section --

SECTION 23 09 13.34 40

CONTROL VALVES, SELF-CONTAINED
02/17

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.1 (2020) Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250

ASME BPVC SEC VI (2017) BPVC Section VI-Recommended Rules for the Care and Operation of Heating Boilers

AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)

ASSE 1003 (2020) Performance Requirements for Water Pressure Reducing Valves for Domestic Water Distribution Systems - (ANSI approved 2010)

ASTM INTERNATIONAL (ASTM)

ASTM A48/A48M (2003; R 2021) Standard Specification for Gray Iron Castings

1.2 ADMINISTRATIVE REQUIREMENTS

Section 23 30 00 HVAC AIR DISTRIBUTION applies to work specified in this section.

Submit fabrication drawings for self-contained control and relief valves, including part numbers and exploded views.

Submit a list of product installations for self-contained control and relief valves, identifying a minimum of five installed units, similar to those proposed for use, that have been in successful service for a minimum period of 5 years.

1.3 SUBMITTALS

Government approval is required for submittals. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Fabrication Drawings;

Installation Drawings;

SD-03 Product Data

Rate-of-Flow Controller;
Nonmodulating Float Valve;
Water Pressure Regulating Valve;
Water Pressure Relief Valve;
Pilot-Operated Pressure Relief Valve;
Sample Warranty;

SD-07 Certificates

List of Product Installations;
Certificates of Conformance;
Manufacturer's Warranty;

SD-06 Test Reports

Test Reports;

1.4 QUALITY ASSURANCE

Submit [certificates of conformance](#) for the following items, showing conformance with the referenced standards contained in this section:

- a. Rate-of-Flow Controller
- b. Nonmodulating Float Valve
- c. Water Pressure Regulating Valve
- d. Water Pressure Relief Valve
- e. Pilot-Operated Pressure Relief Valve
- f. Relief Valves for Electric Water Heaters

Submit a copy of the manufacturer's [sample warranty](#) to the Contracting Officer for review.

PART 2 PRODUCTS

2.1 RATE-OF-FLOW CONTROLLER

Provide a hydraulically operated, pilot-controlled diaphragm globe valve for a rate-of-flow controller, with the pilot control configured to actuate by differential pressure produced across an orifice installed at the inlet. Ensure that the flow rate is adjusted by varying the spring-loading on the pilot. Provide a valve with cast-iron valve body conforming to [ASTM A48/A48M](#), with [125-pound ASME B16.1](#) flanges. Ensure that the valve trim is the manufacturer's standard bronze or AISI 18-8 corrosion-resistant steel, that the orifice plate is made of AISI Type 303

corrosion-resistant steel, and the diaphragm and seal are Buna-N. Ensure that the maximum-service-pressure rating is not less than 175 psi at 180 degrees F.

2.2 NONMODULATING FLOAT VALVE

Provide a nonmodulating float valve that is pilot-controlled, diaphragm-actuated, spring-loaded, single-seated, and hydraulically operated. Mount the pilot valve on the main valve or remotely mount the pilot valve within the cooling tower basin. Ensure that the main valve body is cast iron conforming to ASTM A48/A48M with screwed ends for sizes smaller than 2 inches iron pipe size (ips) and flanges conforming to ASME B16.1 for sizes 2 inch ips and larger, with a brass or bronze pilot valve body, with main and pilot valve trim, including linkage and float, made of the manufacturer's standard bronze-copper or AISI Type 300 series corrosion-resistant steel. Ensure that diaphragm materials and seals are Buna-N, and that this valve has a maximum-service-pressure rating is not less than 175 psi at 180 degrees F. Ensure that the valve operation is the nonslam type.

2.3 WATER PRESSURE-REGULATING VALVE

Provide a direct-acting pressure-regulating valve conforming to ASSE 1003.

Ensure that the pressure-regulating valve does not stick or allow pressure to build up on the low side. Set the valve to maintain a terminal pressure of approximately 5 psi in excess of the static head on the system and operate within a 2-pound maximum variation regardless of initial pressure fluctuation, and without objectionable noise.

2.4 WATER PRESSURE-RELIEF VALVE

Construct, label, and install the pressure-relief valve in accordance with ASME BPVC SEC VI. Ensure that the relieving capacity is as specified by the referenced publication, with valves of nonferrous construction, complete with a test lever.

2.5 PILOT-OPERATED PRESSURE-RELIEF VALVE

Provide a pilot-operated pressure-relief valve that is hydraulically operated and has pilot-controlled modulating, with an adjustable set point over the indicated range. Provide a cast-iron valve body conforming to ASTM A48/A48M, with 125 psi ASME B16.1 flanges. Include the with manufacturer's standard brass, bronze, or corrosion-resistant steel valve trim. Provide pilot control with AISI Type 303 or 304 corrosion-resistant steel trim with Buna-N diaphragm and seal material. Ensure that this valve has a maximum-service-pressure rating of at least 175 psi at 180 degrees F.

PART 3 EXECUTION

3.1 INSTALLATION

Submit installation drawings for self-contained control and relief valves. Install valves as specified in accordance with the manufacturer's recommendations and Section 23 05 15 COMMON PIPING FOR HVAC.

3.2 FIELD QUALITY CONTROL

3.2.1 Test Reports

After the installation has been completed, test the system components and submit 4 copies of the test reports to the Contracting Officer. Remove and replace defective components at no cost to the Government. Retest components and submit reports to the Contracting Officer.

3.3 CLOSEOUT ACTIVITIES

Submit 4 copies of the manufacturer's warranty, to the Contracting Officer before project closeout. Ensure that the warranty has been signed by the Authority Having Jurisdiction (AHJ) and is assigned to the Government.

-- End of Section --

SECTION 23 09 23.02

BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS 02/19, CHG 1: 02/20

PART 1 GENERAL

1.1 SUMMARY

Provide a complete Direct Digital Control (DDC) system, except for the front end which is suitable for the control of the

heating, ventilating and air conditioning (HVAC) and other building-level systems as specified and shown and in accordance with Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.

1.1.1 System Requirements

Provide a system meeting the requirements of both Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC and this Section and with the following characteristics:

- a. Except for Gateways, the control system must be an open implementation of BACnet technology using ASHRAE 135 and Fox as the communications protocols. The system must use standard ASHRAE 135 Objects and Properties and the Niagara Framework. The system must use standard ASHRAE 135 Services and the Niagara Framework exclusively for communication over the network. Gateways to packaged units must communicate with other DDC hardware using ASHRAE 135 or the Fox protocol exclusively and may communicate with packaged equipment using other protocols. The control system must be installed such that any two ASHRAE 135 devices on the Internetwork can communicate using standard ASHRAE 135 Services.

Except for Gateways, the control system must be an open implementation of BACnet technology using ASHRAE 135 as the communications protocol. The system must use standard ASHRAE 135 Objects and Properties. The system must use standard ASHRAE 135 Services exclusively for communication over the network. Gateways to packaged units must communicate with other DDC hardware using ASHRAE 135 exclusively and may communicate with packaged equipment using other protocols. The control system must be installed such that any two devices on the Internetwork can communicate using standard ASHRAE 135 Services.

- b. Install and configure control hardware to provide ASHRAE 135 Objects and Properties or Niagara Framework Objects as indicated and as needed to meet the requirements of this specification.
- c. Use Niagara Framework hardware and software exclusively for scheduling, trending, and communication with a front end (UMCS). Use Niagara Framework or standard BACnet Objects and services for alarming. Use the Fox protocol for all communication between Niagara Framework Supervisory Gateways; use the ASHRAE 135 protocol for all other building communication. Niagara Framework Supervisory Gateway must serve web pages as specified.
- d. Use Niagara Framework Version 4.0 or later.

1.1.2 Verification of Specification Requirements

Review all specifications related to the control system installation and advise the Contracting Officer of any discrepancies before performing any work. If Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC or any other Section referenced in this specification is not included in the project specifications advise the Contracting Officer and either obtain the missing Section or obtain Contracting Officer approval before performing any work.

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 135 (2020; Interpretation 1-8 2021; Errata 1-2 2021; Addenda CD 2021; Addenda BY-CE 2022; Interpretation 9-10 2022) BACnet—A Data Communication Protocol for Building Automation and Control Networks

BACNET INTERNATIONAL (BTL)

BTL Guide (v.49; 2017) BACnet Testing Laboratory Implementation Guidelines

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 802.3 (2022) Ethernet

TELECOMMUNICATIONS INDUSTRY ASSOCIATION (TIA)

TIA-485 (1998a; R 2012) Electrical Characteristics of Generators and Receivers for Use in Balanced Digital Multipoint Systems

TRIDIUM, INC (TRIDIUM)

Niagara Framework (2012) NiagaraAX User's Guide

Tridium Open NiCS (2005) Understanding the NiagaraAX Compatibility Statement (NiCS)

U.S. FEDERAL COMMUNICATIONS COMMISSION (FCC)

FCC Part 15 Radio Frequency Devices (47 CFR 15)

UNDERWRITERS LABORATORIES (UL)

UL 916 (2015; Reprint Oct 2021) UL Standard for Safety Energy Management Equipment

1.3 DEFINITIONS

For definitions related to this section, see Section 23 09 00

INSTRUMENTATION AND CONTROL FOR HVAC.

1.4 SUBMITTALS

Submittal requirements related to this Section are specified in Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.

PART 2 PRODUCTS

All products used to meet this specification must meet the indicated requirements, but not all products specified here will be required by every project. All products must meet the requirements both Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC and this Section.

2.1 NETWORK HARDWARE

2.1.1 BACnet Router

All BACnet Routers must be BACnet/IP Routers and must perform layer 3 routing of ASHRAE 135 packets over an IP network in accordance with ASHRAE 135 Annex J and Clause 6. The router must provide the appropriate connection to the IP network and connections to one or more ASHRAE 135 MS/TP networks. Devices used as BACnet Routers must meet the requirements for DDC Hardware, and except for Niagara Framework Supervisory Gateways, devices used as BACnet routers must support the NM-RC-B BIBB.

2.1.2 BACnet Gateways

In addition to the requirements for DDC Hardware, the BACnet Gateway must be a Niagara Framework Supervisory Gateway or must meet the following requirements:

- a. It must perform bi-directional protocol translation from one non-ASHRAE 135 protocol to ASHRAE 135. BACnet Gateways must incorporate a network connection to an ASHRAE 135 network (either BACnet over IP in accordance with Annex J or MS/TP) and a separate connection appropriate for the non-ASHRAE 135 protocol and media.
- b. It must retain its configuration after a power loss of an indefinite time, and must automatically return to their pre-power loss state once power is restored.
- c. It must allow bi-directional mapping of data between the non-ASHRAE 135 protocol and Standard Objects as defined in ASHRAE 135. It must support the DS-RP-B BIBB for Objects requiring read access and the DS-WP-B BIBB for Objects requiring write access.
- d. It must support the DS-COV-B BIBB.

Although Gateways must meet DDC Hardware requirements , except for Niagara Framework Supervisory Gateways, they are not DDC Hardware and must not be used when DDC Hardware is required. (Niagara Framework Supervisory Gateways are both Gateways and DDC Hardware.)

2.1.3 Ethernet Switch

Ethernet Switches must be managed switches and must autoconfigure between 10,100 and 1000 megabits per second (MBPS).

2.2 CONTROL NETWORK WIRING

- a. BACnet MS/TP communications wiring must be in accordance with [ASHRAE 135](#). The wiring must use shielded, three wire (twisted-pair with reference) cable with characteristic impedance between 100 and 120 ohms. Distributed capacitance between conductors must be less than 30 pF per foot.
- b. Building Control Network Backbone IP Network must use Ethernet media. Ethernet cables must be CAT-5e at a minimum and meet all requirements of [IEEE 802.3](#).

2.3 DIRECT DIGITAL CONTROL (DDC) HARDWARE

2.3.1 General Requirements

All DDC Hardware must meet the following requirements:

- a. It must be locally powered and must incorporate a light to indicate the device is receiving power.
- b. It must conform to the [BTL Guide](#)
- c. It must be BACnet Testing Laboratory (BTL) Listed.
- d. The Manufacturer's Product Data submittal for each piece of DDC Hardware must include the Protocol Implementation Conformance Statement (PICS) for that hardware as specified in Section [23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC](#).
- e. It must communicate and be interoperable in accordance with [ASHRAE 135](#) and have connections for BACnet IP or MS/TP control network wiring.
- f. Other than devices controlling terminal units or functioning solely as a BACnet Router, it must support DS-COV-B, DS-RPM-A and DS-RPM-B BIBBs.
- g. Devices supporting the DS-RP-A BIBB must also support the DS-COV-A BIBB.
- h. Application programs, configuration settings and communication information must be stored in a manner such that they persist through loss of power:
 - (1) Application programs must persist regardless of the length of time power is lost.
 - (2) Configured settings must persist for any loss of power less than 2,500 hours.
 - (3) Communication information, including but not limited to COV subscriptions, event reporting destinations, Notification Class Object settings, and internal communication settings, must persist for any loss of power less than 2,500 hours.
- i. Internal Clocks:
 - (1) Clocks in DDC Hardware incorporating a Clock must continue to function for 120 hours upon loss of power to the DDC Hardware.

- (2) DDC Hardware incorporating a Clock must support the DM-TS-B or DM-UTC-B BIBB.
- j. It must have all functionality indicated and required to support the application (Sequence of Operation or portion thereof) in which it is used, including but not limited to providing Objects or Niagara Framework Points as specified and as indicated on the Points Schedule.
- k. In addition to these general requirements and the DDC Hardware Input-Output (I/O) Function requirements, all DDC Hardware must also meet any additional requirements for the application in which it is used (e.g. scheduling, alarming, trending, etc.).
- l. It must meet FCC Part 15 requirements and have UL 916 or equivalent safety listing.
- m. Except for Niagara Framework Supervisory Gateways, Device must support Commandable Objects to support Override requirements as detailed in PART 3 EXECUTION
- n. User interfaces which allow for modification of Properties or settings must be password-protected.
- o. Devices communicating BACnet MS/TP must meet the following requirements:
 - (1) Must have a configurable Max_Master Property.
 - (2) DDC Hardware other than hardware controlling a single terminal unit must have a configurable Max_Info_Frames Property.
 - (3) Must respond to any valid request within 50 msec with either the appropriate response or with a response of "Reply Postponed".
 - (4) Must use twisted pair with reference and shield (3-wire media) wiring, or twisted pair with shield (2-wire media) wiring and use half-wave rectification.
- p. Devices communicating BACnet/IP must use UDP Port 0xBAC0. Devices with configurable UDP Ports must default to 0xBAC0.
- q. All Device IDs, Network Numbers, and BACnet MAC addresses of devices must be fully configurable without limitation, except MS/TP MAC addresses may be limited by ASHRAE 135 requirements.
- r. Except for Niagara Framework Supervisory Gateways, DDC Hardware controlling a single terminal unit must have:
 - (1) Objects (including the Device Object) with an Object Name Property of at least 8 characters in length.
 - (2) A configurable Device Object Name.
 - (3) A configurable Device Object Description Property at least 16 characters in length.
- s. Except for Objects in either Niagara Framework Supervisory Gateways or DDC Hardware controlling a single terminal unit, all Objects

(including Device Objects) must:

- (1) Have a configurable Object Name Property of at least 12 characters in length.
 - (2) Have a configurable Object Description Property of at least 24 characters in length.
- t. For programmable DDC Hardware, provide and license to the project site all programming software required to program the Hardware in accordance with Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.
- u. For programmable DDC Hardware, provide copies of the installed application programs (all software that is not common to every controller of the same manufacturer and model) as source code compatible with the supplied programming software in accordance with Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC. The submitted application program must be the complete application necessary for controller to function as installed and be sufficient to allow replacement of the installed controller with another controller of the same type.

2.3.2 Hardware Input-Output (I/O) Functions

DDC Hardware incorporating hardware input-output (I/O) functions must meet the following requirements:

2.3.2.1 Analog Inputs

DC Hardware analog inputs (AIs) must be implemented using [ASHRAE 135](#) Analog Input Objects and perform analog to digital (A-to-D) conversion with a minimum resolution of 8 bits plus sign or better as needed to meet the accuracy requirements specified in Section 23 09 00. Signal conditioning including transient rejection must be provided for each analog input. Analog inputs must be capable of being individually calibrated for zero and span. Calibration via software scaling performed as part of point configuration is acceptable. The AI must incorporate common mode noise rejection of at least 50 dB from 0 to 100 Hz for differential inputs, and normal mode noise rejection of at least 20 dB at 60 Hz from a source impedance of 10,000 ohms.

2.3.2.2 Analog Outputs

DDC Hardware analog outputs (AOs) must be implemented using [ASHRAE 135](#) Analog Output Objects and perform digital to analog (D-to-A) conversion with a minimum resolution of 8 bits plus sign, and output a signal with a range of 4-20 mAdc or 0-10 Vdc. Analog outputs must be capable of being individually calibrated for zero and span. Calibration via software scaling performed as part of point configuration is acceptable. DDC Hardware with Hand-Off-Auto (H-O-A) switches for analog outputs must provide for overriding the output through the range of 0 percent to 100 percent

2.3.2.3 Binary Inputs

DDC Hardware binary inputs (BIs) must be implemented using [ASHRAE 135](#) Binary Input Objects and accept contact closures and must ignore transients of less than 5 milli-second duration. Protection against a transient 50VAC must be provided.

2.3.2.4 Binary Outputs

DDC Hardware binary outputs (BOs) must be implemented using [ASHRAE 135](#) Binary Output Objects and provide relay contact closures or triac outputs for momentary and maintained operation of output devices. DDC Hardware with H-O-A switches for binary outputs must provide for overriding the output open or closed.

2.3.2.4.1 Relay Contact Closures

Closures must have a minimum duration of 0.1 second. Relays must provide at least 180V of isolation. Electromagnetic interference suppression must be provided on all output lines to limit transients to 50 Vac. Minimum contact rating must be 0.5 amperes at 24 Vac.

2.3.2.4.2 Triac Outputs

Triac outputs must provide at least 180 V of isolation. Minimum contact rating must be 0.5 amperes at 24 Vac.

2.3.2.5 Pulse Accumulator

DDC Hardware pulse accumulators must be implemented using either an [ASHRAE 135](#) Accumulator Object or an [ASHRAE 135](#) Analog Value Object where the Present_Value is the totalized pulse count. Pulse accumulators must accept contact closures, ignore transients less than 5 msec duration, protect against transients of 50 VAC, and accept rates of at least 20 pulses per second.

2.3.2.6 ASHRAE 135 Objects for Hardware Inputs and Outputs

The requirements for use of [ASHRAE 135](#) objects for hardware input and outputs includes devices where the hardware sensor or actuator is integral to the controller (e.g. a VAV box with integral damper actuator, a smart sensor, a VFD, etc.)

2.3.2.7 Integrated H-O-A Switches

Where integrated H-O-A switches are provided on hardware outputs, controller must provide means of monitoring position or status of H-O-A switch. This feedback may be provided via [the Niagara Framework or via](#) any valid BACnet method, including the use of proprietary Objects, Properties, or Services.

2.3.3 Local Display Panel (LDP)

The Local Display Panels (LDPs) must be DDC Hardware with a display and navigation buttons or a touch screen display, and must provide display and adjustment of [Niagara Framework points or ASHRAE 135](#) Properties as indicated on the Points Schedule and as specified. LDPs must be either BTL Listed as a B-OD, B-OWS, B-AWS, or be an integral part of another piece of DDC Hardware listed as a B-BC. For LDPs listed as B-OWS or B-AWS, the hardware must be BTL listed and the product must come factory installed with all applications necessary for the device to function as an LDP.

The adjustment of values using display and navigation buttons must be

password protected.

2.3.4 Expansion Modules and Tethered Hardware

A single piece of DDC Hardware may consist of a base unit and also:

- a. An unlimited number of hardware expansion modules, where the individual hardware expansion modules are designed to directly connect, both mechanically and electrically, to the base unit hardware. The expansion modules must be commercially available as an optional add-on to the base unit.
- b. A single piece of hardware connected (tethered) to a base unit by a single cable where the cable carries a proprietary protocol between the base unit and tethered hardware. The tethered hardware must not contain control logic and be commercially available as an optional add-on to the base unit as a single package.

Note that this restriction on tethered hardware does not apply to sensors or actuators using standard binary or analog signals (not a communications protocol); sensors or actuators using standard binary or analog signals are not considered part of the DDC Hardware.

Hardware capable of being installed stand-alone, or without a separate base unit, is DDC Hardware and must not be used as expansion modules or tethered hardware.

2.3.5 Supervisory Control Requirements

2.3.5.1 Scheduling Hardware

DDC Hardware used for scheduling must meet the following requirements:

- a. It must be BTL Listed as a B-BC and support the SCHED-E-B BIBB.
- b. It is preferred, but not required, that devices support the DM-OCD-B BIBB on all Calendar and Schedule Objects, such that a front end BTL listed as a B-AWS may create or delete Calendar and Schedule Objects. It is also preferred but not required that devices supporting the DM-OCD-B BIBB accept any valid value for properties of Calendar and Schedule Objects. Note that there are additional requirements in the EXECUTION Part of this Section for Devices which do not support the DM-OCD-B BIBB as specified.
- c. The Date_List property of all Calendar Objects must be writable.
- d. The Present_Value Property of Schedule must support the following values: 1, 2, 3, 4.

2.3.5.2 Alarm Generation Hardware

Non-Niagara Framework DDC Hardware used for alarm generation must meet the following requirements:

- a. Device must support the AE-N-I-B BIBB
- b. The Recipient_List Property must be Writable for all Notification Class Objects used for alarm generation.

- c. For all Objects implementing Intrinsic Alarming, the following Properties must be Writable:
 - (1) Time_Delay
 - (2) High_Limit
 - (3) Low_Limit
 - (4) Deadband
 - (5) Event_Enable
 - (6) If the issue date of this project specification is after 1 January 2016, Time_Delay_Normal must be writable.
- d. It is preferred, but not required, that devices support the DM-OCD-B BIBB on all Notification Class Objects. It is also preferred, but not required that devices supporting the DM-OCD-B BIBB accept any valid value as an initial value for properties of Notification Class Objects.
- d. For Event Enrollment Objects used for alarm generation, the following Properties must be Writable:
 - (1) Event_Parameters
 - (2) Event_Enable
 - (3) If the issue date of this project specification is after 1 January 2016, Time_Delay_Normal must be writable.
- e. It is preferred, but not required, that devices support the DM-OCD-B BIBB on all Notification Class Objects and Event Enrollment Objects, such that a front end BTL listed as a B-AWS may create or delete Notification Class Objects and Event Enrollment Objects. It is also preferred, but not required that devices supporting the DM-OCD-B BIBB accept any valid value as an initial value for properties of Notification Class Objects and Event Enrollment Objects. Note that there are additional requirements in the EXECUTION Part of this Section for devices which do not support the DM-OCD-B BIBB as specified.
- f. Devices provided to meet the the requirements indicated under "Support for Future Alarm Generation" in the EXECUTION part of this specification must support the AE-N-E-B BIBB.

2.3.5.3 Trending Hardware

DDC Hardware used for collecting trend data must meet the following requirements:

- a. Device must support Trend Log or Trend Log Multiple Objects.
- b. Device must support the T-VMT-I-B BIBB.
- c. Devices provided to meet the EXECUTION requirement for support of Future Trending must support the T-VMT-E-B BIBB.
- d. The following properties of all Trend Log or Trend Log Multiple Objects must be present and Writable:
 - Start_Time
 - Stop_Time
 - Log_DeviceObjectProperty
 - Log Interval Log interval must support an interval of at least 60 minutes duration.
- e. Trend Log Objects must support using Intrinsic Reporting to send a BUFFER_FULL event.

- f. The device must have a Notification Class Object for the BUFFER_FULL event. The Recipient_List Property must be Writable.
- g. Devices must support values of at least 1,000 for Buffer_Size Properties.
- h. It is preferred, but not required, that devices support the DM-OCD-B BIBB on all Trend Log Objects, such that a front end BTL listed as a A-AWS may create or delete Trend Log Objects. It is also preferred, but not required that devices supporting the DM-OCD-B BIBB accept any valid value as an initial value for properties of Trend Log Objects. Note that there are additional EXECUTION requirements for devices which do not support the DM-OCD-B BIBB as specified.

2.3.6 Niagara Framework Supervisory Gateway

Any device implementing the Niagara Framework is a Niagara Framework Supervisory Gateway and must meet these requirements. In addition to the general requirements for all DDC Hardware, Niagara Framework Supervisory Gateway Hardware must:

- a. Be direct digital control hardware.
- b. Have an unrestricted interoperability license and its Niagara Compatibility Statement (NiCS) must follow the Tridium Open NiCS Specification.
- c. Manage communications between a field control network and the Niagara Framework Monitoring and Control Software, and between itself and other Niagara Framework Supervisory Gateways. Niagara Framework Supervisory Gateway Hardware must use Fox protocol for communication with other Niagara Framework Components, regardless of the manufacturer of the other components.
- d. Be fully programmable using the Niagara Framework Engineering Tool and must support the following:
 - (1) Time synchronization, Calendar, and Scheduling using Niagara Scheduling Objects
 - (2) Alarm generation and routing using the Niagara Alarm Service
 - (3) Trending using the Niagara History Service and Niagara Trend Log Objects
 - (4) Integration of field control networks using the Niagara Framework Engineering Tool
 - (5) Configuration of integrated field control system using the Niagara Framework Engineering Tool when supported by the field control system
- e. Meet the following minimum hardware requirements:
 - (1) One 10/100 Mbps Ethernet Port
 - (2) One or more MS/TP ports.

- f. Provide access to field control network data and supervisory functions via web interface and support a minimum of 16 simultaneous users. Note: implementation of this capability may not be required on all projects.
- g. Submit a backup of each Niagara Framework Supervisory Gateway as specified in Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC. The backup must be sufficient to restore a Niagara Framework Supervisory Gateway to the final as-built condition such that a new Niagara Framework Supervisory Gateway loaded with the backup is indistinguishable in functionality from the original.

2.4 NIAGARA FRAMEWORK ENGINEERING TOOL

The Niagara Framework Engineering Tool must be Niagara Workbench or an equivalent Niagara Framework engineering tool software must:

- a. Have an unrestricted interoperability license and its Niagara Compatibility Statement (NiCS) must follow the Tridium Open NiCS Specification.
- b. Be capable of performing network configuration for Niagara Framework Supervisory Gateways and Niagara Framework Monitoring and Control Software.
- c. Be capable of programming and configuring of Niagara Framework Supervisory Gateways and Niagara Framework Monitoring and Control Software.
- d. Be capable of discovery of Niagara Framework Supervisory Gateways and all points mapped into each Niagara Framework Supervisory Gateway and making these points accessible to Niagara Framework Monitoring and Control Software.

PART 3 EXECUTION

3.1 CONTROL SYSTEM INSTALLATION3.1.1 Building Control Network (BCN)

Install the Building Control Network (BCN) as a single BACnet Internetwork consisting of a single IP network as the BCN Backbone and zero or more BACnet MS/TP networks. Note that in some cases there may only be a single device on the BCN Backbone.

Except for the IP Network and as permitted for the non-BACnet side of Gateways, use exclusively ASHRAE 135 networks.

3.1.1.1 Building Control Network IP Backbone

Install IP Network Cabling in conduit. Install Ethernet Switches in lockable enclosures. Install the Building Control Network (BCN) IP Backbone such that it is available at the Facility Point of Connection (FPOC) location as indicated. When the FPOC location is a room number, provide sufficient additional media to ensure that the Building Control Network (BCN) IP Backbone can be extended to any location in the room.

Use UDP port 0xBAC0 for all BACnet traffic on the IP network. (Note that

in a Niagara Framework system there may not be BACnet traffic on the IP Network)

3.1.1.2 BACnet MS/TP Networks

When using MS/TP, provide MS/TP networks in accordance with [ASHRAE 135](#) and in accordance with the [ASHRAE 135](#) figure "Mixed Devices on 3-Conductor Cable with Shield" (Figure 9-1.4 in the 2012 version of ASHRAE 135). Ground the shield at the BACnet Router and at no other point. Ground the reference wire at the BACnet Router through a 100 ohm resistor and do not ground it at any other point. In addition:

- a. Provide each segment in a doubly terminated bus topology in accordance with [TIA-485](#).
- b. Provide each segment with 2 sets of network bias resistors in accordance with [ASHRAE 135](#), with one set of resistors at each end of the MS/TP network.
- c. Use 3 wire (twisted pair and reference) with shield media for all MS/TP media installed inside. Use fiber optic isolation in accordance with [ASHRAE 135](#) for all MS/TP media installed outside buildings, or between multiple buildings.
- d. For 18 AWG cable, use segments with a maximum length of [4000 ft](#). When using greater distances or different wire gauges comply with the electrical specifications of [TIA-485](#).
- e. For each controller that does not use the reference wire provide transient suppression at the network connection of the controller if the controller itself does not incorporate transient suppression.
- f. Install no more than 32 devices on each MS/TP segment. Do not use MS/TP to MS/TP routers.
- g. Connect each MS/TP network to the BCN backbone via [a Niagara Framework Supervisory Gateway configured as a BACnet Router](#).
- h. For BACnet Routers, configure the MS/TP MAC address to 0. Assign MAC Addresses to other devices consecutively beginning at 1, with no gaps.
- i. Configure the Max_Master Property of all devices to be 31.

3.1.1.3 Building Control Network (BCN) Installation

Provide a building control network meeting the following requirements:

- a. Install all DDC Hardware connected to the Building Control Network.
- b. Where multiple pieces of DDC Hardware are used to execute one sequence, install all DDC Hardware executing that sequence on a single MS/TP network dedicated to that sequence.
- c. Traffic between BACnet networks must be exclusively via BACnet routers.
- d. [Use the Fox protocol for all traffic both originating and terminating at Niagara Framework components. Use the Fox protocol for all traffic originating or terminating at a Niagara Framework UMCS \(including](#)

traffic to or from a future UMCS). All other traffic, including traffic between ASHRAE 135 devices and traffic between Niagara Framework Supervisory Gateways and ASHRAE 135 devices must be in accordance with ASHRAE 135.

3.1.2 DDC Hardware

Install all DDC Hardware that connects to an IP network in lockable enclosure. Install other DDC Hardware that is not in suspended ceilings in lockable enclosures. For all DDC hardware with a user interface, coordinate with site to determine proper passwords and configure passwords into device.

- a. Except for zone sensors (thermostats), install all Tethered Hardware within 6 feet of its base unit.
- b. Install and configure all BTL-Listed devices in a manner consistent with their BTL Listing such that the device as provided still meets all requirements necessary for its BTL Listing.
- c. Install and configure all BTL-Listed devices in a manner consistent with the BTL Device Implementation Guidelines such that the device as provided meets all those Guidelines.

3.1.2.1 Device Identifiers, Network Addresses, and IP addresses

- a. Do not use any Device Identifier or Network Number already used by another BACnet system at the project site. Coordinate Device IDs and Network Numbers with the installation. The installation POC is Contracting Officer .
- b. Coordinate device IP addresses with installation. The installation POC is Contracting Officer.

3.1.2.2 ASHRAE 135 Object Name Property and Object Description Property

Configure the Object_Names and Object_Descriptions properties of all ASHRAE 135 Objects (including Device Objects) as indicated on the Points Schedule (Point Name and Point Description) and as specified. At a minimum:

- a. Except for DDC Hardware controlling a single terminal unit, configure the Object_Name and Object_Description properties of all Objects (including Device Objects) as indicated on the Points Schedule and as specified.
- b. In DDC Hardware controlling a single terminal unit, configure the Device Object_Name and Device Object_Description as indicated on the Points Schedule and as specified.

When Points Schedule entries exceed the length limitations in the device, notify POC and provide recommended alternatives for approval.

3.1.2.3 Niagara Framework Point Names and Descriptions

Configure the names and descriptions of all Points in Niagara Framework Supervisory Gateways as indicated on the Points Schedule and as specified.

3.1.2.4 Niagara Station IDs

Ensure that Niagara Station IDs of new Niagara Framework Supervisory

Gateways are maintained as unique within UMCS front-end, including ensuring they do not conflict with any existing Niagara Station ID.

3.1.2.5 Hand-Off-Auto (H-O-A) Switches

Provide Hand-Off-Auto (H-O-A) switches for all DDC Hardware analog outputs and binary outputs used for control of systems other than terminal units, as specified and as indicated on the Points Schedule. Provide H-O-A switches that are integral to the controller hardware, an external device co-located with (in the same enclosure as) the controller, integral to the controlled equipment, or an external device co-located with (in the same enclosure as) the controlled equipment.

- a. For H-O-A switches integral to DDC Hardware, meet the requirements specified in paragraph DIRECT DIGITAL CONTROL (DDC) HARDWARE.
- b. For external H-O-A switches used for binary outputs, provide for overriding the output open or closed.
- c. For external H-O-A switches used for analog outputs, provide for overriding through the range of 0 percent to 100 percent.

3.1.2.6 Local Display Panels

Provide LDPs to display and override values of points in a Niagara Framework Supervisory Gateway or ASHRAE 135 Object Properties as indicated on the Points Schedule. Install LDPs displaying points for anything other than a terminal unit in the same room as the equipment. Install LDPs displaying points for only terminal units in a mechanical room central to the group of terminal units it serves. For LDPs using WriteProperty to commandable objects to implement an override, write values with priority 9.

3.1.2.7 MS/TP Slave Devices

Configure all MS/TP devices as Master devices. Do not configure any devices to act as slave devices.

3.1.2.8 Change of Value (COV) and Read Property

- a. To the greatest extent possible, configure all devices to support the SubscribeCOV service (the DS-COV-B BIBB). At a minimum, all devices supporting the DS-RP-B BIBB, other than devices controlling only a single terminal unit, must be configured to support the DS-COV-B BIBB.
- b. Whenever supported by the server side, configure client devices to use the DS-COV-A BIBB.

3.1.2.9 Engineering Units

Configure devices to use English (Inch-Pound) engineering units as follows:

- a. Temperature in degrees F
- b. Air or natural gas flows in cubic feet per minute (CFM)
- c. Water in gallons per minute (GPM)
- d. Steam flow in pounds per hour (pph)

- e. Differential Air pressures in inches of water column (IWC)
- f. Water, steam, and natural gas pressures in PSI
- g. Enthalpy in BTU/lb
- h. Heating and cooling energy in MBTU (1MBTU = 1,000,000 BTU))
- i. Cooling load in tons (1 ton = 12,000 BTU/hour)
- j. Heating load in MBTU/hour (1MBTU = 1,000,000 BTU)
- k. Electrical Power: kilowatts (kW)
- l. Electrical Energy: kilowatt-hours (kWh)

3.1.2.10 Occupancy Modes

Use the following correspondence between value and occupancy mode whenever an occupancy state or value is required:

- a. OCCUPIED mode: a value of one
- b. UNOCCUPIED mode: a value of two
- c. WARM-UP/COOL-DOWN (PRE-OCCUPANCY) mode: a value of three

Note that elsewhere in this Section the Schedule Object is required to also support a value of four, which is reserved for future use. Also note that the behavior of a system in each of these occupancy modes is indicated in the sequence of operation for the system.

3.1.2.11 Use of BACnet Objects

Except as specifically indicated for Niagara Framework Objects, Use only standard non-proprietary ASHRAE 135 Objects and services to accomplish the project scope of work as follows:

- a. Use Analog Input or Analog Output Objects for all analog hardware I/O. Do not use Analog Value Object for analog hardware I/O).
- b. Use Binary Input or Binary Output Objects for all binary hardware I/O. Do not use Binary Value Objects for binary hardware I/O.
- c. Use Analog Value Objects for analog setpoints.
- d. Use Accumulator Objects or Analog Value Objects for pulse inputs.
- e. For occupancy modes, use Multistate Value Objects and the correspondence between value and occupancy mode specified in paragraph OCCUPANCY MODES.
- f. Use Schedule Objects and Calendar Objects for all scheduling. Use Trend Log Objects or Trend Log Multiple Objects for all trending and Notification Class Objects for trend log upload. Use a combination of Event Enrollment Objects, Intrinsic Alarming, and Notification Class Objects for alarm generation.
- f. Use a combination of Niagara Framework Alarm Extensions and Alarm Services, Intrinsic Alarming, and Notification Class Objects for alarm generation.

- g. For all other points shown on the Points Schedule as requiring an **ASHRAE 135** Object, use the Object type shown on the Points Schedule or, if no Object Type is shown, use a standard Object appropriate to the point.

3.1.2.11.1 Niagara Framework Objects

Points in the Niagara Framework Supervisory Gateway, even if used in a sequence or are shown on the Points Schedule, are not required to be exposed as BACnet Objects unless they are required to be available on the network by another device or sequence of operation (i.e. there is some other reason they are needed).

Use a Niagara Framework Supervisory Gateway as specified for all scheduling and trending. Use a Niagara Framework Supervisory Gateway as specified for all alarming except for intrinsic alarming.

3.1.2.12 Use of Standard BACnet Services

Except as noted in this paragraph, for all DDC Hardware (including Niagara Frameworks Supervisory Gateways when communicating with non-Niagara Framework DDC Hardware) use Standard BACnet Services as defined in this specification (which excludes some **ASHRAE 135** services) exclusively for application control functionality and communication.

DDC Hardware that cannot meet this requirement may use non-standard services provided they can provide identical functionality using Standard BACnet Services when communicating with BACnet devices from a different vendor. When implementing non-standard services, document all non-standard services in the DDC Hardware Schedule as specified and as specified in Section **23 09 00** INSTRUMENTATION AND CONTROL FOR HVAC.

3.1.2.13 Device Application Configuration

- a. For every property, setting or value shown on the Points Schedule or otherwise indicated as Configurable, provide a value that is retained through loss of power and can be changed via one or more of:
 - (1) BACnet services (including proprietary services)
 - (2) Hardware settings on the device
 - (3) The Niagara Framework
- b. For every property, setting or value in non-Niagara Framework Hardware shown on the Points Schedule or otherwise indicated as Operator Configurable, provide a value that is retained through loss of power and can be changed via one or more of:
 - (1) A Writable Property of a standard BACnet Object
 - (2) A Property of a standard BACnet Object that is Writable when Out_Of_Service is TRUE and Out_Of_Service is Writable.
 - (3) Using some other method supported by a Niagara Framework Supervisory Gateway
- c. Configure Niagara Framework Supervisory Gateways such that the property, setting or value is configurable from a Niagara Framework

Front End.

- d. For every property, setting or value in a Niagara Framework Supervisory Gateway which is shown on the Points Schedule or otherwise indicated as Operator Configurable, configure the value to be configurable from within the Niagara Framework such that it can be configured from a system graphic page at a Niagara Framework Front End.

3.1.2.14 Niagara Framework Engineering Tool

Use the Niagara Framework Engineering Tool to fully discover the field control system and make all field control system information available to the Niagara Framework Supervisory Gateway. Ensure that all points on the points schedule are available to the front end via the Fox protocol.

3.1.2.15 Graphics and Web Pages

Configure Niagara Framework Supervisory Gateways to use web pages to provide a graphical user interface including System Displays, including overrides, as indicated on the Points Schedule and as specified. Label all points on displays with full English language descriptions. Configure user permissions for access to and executions of action using graphic pages. Coordinate user permissions with the Controls shop supervisor. Configure the web server to use HTTPS based on the Transport Layer Security (TLS) protocol in accordance with RFC 5246 using a Government furnished certificate.

3.1.3 Scheduling, Alarming, Trending, and Overrides

3.1.3.1 Scheduling

Configure schedules in BACnet Scheduling Objects to schedule systems as indicated on the Points Schedule and as specified using the indicated correspondence between value and occupancy mode. If no devices supports both the SCHED-E-B and DM-OCD-B BIBBS for Schedule Objects, provide 5 blank Schedule Objects in DDC Hardware BTL listed as B-BCs and supporting the SCHED-E-B BIBB for later use by the site. Configure schedules in Niagara Framework Supervisory Gateway using Niagara Schedule Objects as indicated on the Points Schedule and as specified. When the schedule is controlling occupancy modes in DDC Hardware other than a Niagara Framework Supervisory Gateway use the indicated correspondence between value and occupancy mode.

Provide a separate schedule for each AHU including it's associated Terminal Units and for each stand-alone Terminal Unit (those not dependent upon AHU service).

3.1.3.2 Alarm Configuration

Configure alarm generation and management as indicated on the Points Schedule and as specified. Configure alarm generation in Niagara Framework Supervisory Gateways using Niagara Framework Alarm Extensions and Alarm Services or in other DDC Hardware (not Niagara Framework Supervisory Gateways) using ASHRAE 135 Intrinsic Alarming. Configure alarm management and routing for all alarms, including those generated via intrinsic alarming in other devices, in the Niagara Framework Supervisory Gateway such that the alarms are able to be accessed from the Niagara Framework Front End.

Where Intrinsic Alarming is used, configure intrinsic alarming as specified in paragraph "Configuration of ASHRAE 135 Intrinsic Alarm Generation". Configure a Niagara Framework Supervisory Gateway to provide a means to configure the intrinsic alarm parameters such that the Intrinsic Alarm is configurable from the front end via the Niagara Framework.

3.1.3.3 Configuration of ASHRAE 135 Intrinsic Alarm Generation

Intrinsic alarm generation must meet the following requirements:

Configure alarm generation as indicated on the Points Schedule and as specified using Intrinsic Alarming in accordance with ASHRAE 135 or Algorithmic Alarming in accordance with ASHRAE 135. Alarm generation must meet the following requirements:

- a. Send alarm events as Alarms (not Events).
- b. Use the ConfirmedNotification Service for alarm events.
- c. For alarm generation, support two priority levels for alarms: critical and non-critical. Configure the Priority of Notification Class Objects to use Priority 112 for critical and 224 for non-critical alarms.
- d. Number of Notification Class Objects for Alarm Generation:
 - (1) If the device implements non-critical alarms, or if any Object in the device supports Intrinsic Alarms, then provide a single Notification Class Object specifically for (shared by) all non-critical alarms.
 - (2) If the device implements critical alarms, provide a single Notification Class Object specifically for (shared by) all critical alarms.
 - (3) If the device implements both critical and non-critical alarms, provide both Notification Class Objects (one for critical, one for non-critical).
 - (4) If the device controls equipment other than a single terminal unit, provide both Notification Class Objects (one for critical, one for non-critical) even if no alarm generation is required at time of installation.
- e. For all intrinsic alarms configure the Limit_Enable Property to set both HighLimitEnable and LowLimitEnable to TRUE. If the specified alarm conditions are for a single-sided alarm (only High_Limit used or only Low_Limit used) assign a value to the unused limit such that the unused alarm condition will not occur.
- f. For all objects supporting intrinsic alarming, even if no alarm generation is required during installation, configure the following Properties as follows:
 - (1) Notification_Class to point to the non-Critical Notification Class Object in that device.

(2) Limit_Enable to enable both the HighLimitEnable and LowLimitEnable

(3) Notify_Type to Alarm

g. Use of alarm generation types:

(1) Only use algorithmic alarm generation when intrinsic alarm generation is not supported by the device or object, or when the specific alarm conditions cannot be implemented using intrinsic alarm generation.

(2) Only use remote alarm generation when the alarm cannot be generated using intrinsic or local algorithmic alarm generation on the device containing the referenced property. If remote alarm generation is used, use the same DDC Hardware for all remote alarm generation within a single sequence.

g. Configure the Recipient_List Property of the Notification Class Object to point to the Niagara Framework Supervisory Gateway managing the alarm.

3.1.3.4 Support for Future Alarm Generation

For every piece of DDC Hardware, support future alarm generation capabilities by supporting either intrinsic or additional algorithmic alarming. Provide one of the following:

a. Support intrinsic alarming for every Object used by the application in that device.

b. Support additional Event_Enrollment Objects. For DDC hardware controlling a single terminal unit, support at least one additional object. Otherwise, support at least 4 additional Objects. Support additional Event_Enrollment Objects via one of the following:

(1) Provide unused Event_Enrollment Objects on that device.

(2) Support the DM-OCD-B BIBB and the creation of sufficient Event_Enrollment Objects on that device.

(3) Provide one or more devices in the IP network that support the AE-N-E-B BIBB and have unused Event_Enrollment Objects.

(4) Provide one or more devices on the IP network that support the AE-N-E-B BIBB, the DM-OCD-B BIBB, and the creation of sufficient Event_Enrollment Objects.

The total number of Event_Enrollment Objects required by the project is the sum of the individual device requirements, and the distribution of Event_Enrollment Objects among devices is not further restricted. (Note this allows a single device to contain many Event_Enrollment Objects satisfying the requirements for multiple devices.)

3.1.3.5 Trend Log Configuration

a. Configure trends in Trend Log or Trend Log Multiple Objects as indicated on the Points Schedule and as specified.

b. Configure all trend logs (including any provided to support future

trends) to save data on regular intervals using the BUFFER_FULL event to request trend upload from the front end.

- c. Configure Trend Log Objects with a minimum Buffer_Size property value of 1,000 and Trend Log Multiple Objects with a minimum Buffer_Size property value of 1,000 per point trended (for example, a Trend Log Multiple Object used to trend 3 points must have a Buffer_Size Property value of at least 3,000).
- d. Configure a Notification Class Object in devices doing trending (including devices supporting future trends) to handle the BUFFER_FULL event.
- e. When possible, trend each point using an Object in the device containing the point. When it is necessary to trend using a an Object in another device, all trends not on the same Device as the Object being trended must be on a single device (i.e. all Trend Log and Trend Log Multiple Objects used for remote trending within a sequence must be on the same device).
- f. For each trend log, including any trend logs provided to support future trending, configure the following properties as specified:
 - (1) Logging_Type: Set to Polling
 - (2) Stop_When_Full: Set to Wrap Around
 - (3) Buffer_Size: Set to 400 or greater.
 - (4) Notification_Threshold: Set to 90 percent of full
 - (5) Notification_Class: Set to the Notification Class Object in that device
 - (6) Event_Enable: Set to TRUE
 - (7) Log_Interval: Set to 15 minutes.
- g. Future Trending support. Provide support for future trending:
 - (1) Provide one or more devices on the Building Control Network Backbone IP network which support both the T-VMT-E-B and DM-OCD-B BIBBs for Trend Log Objects. Provide sufficient devices to support the creation of at least 2 additional Trend Log Objects plus 4 additional Trend Log Objects for every non-terminal unit.
 - (2) Provide one additional Trend Log Object for every terminal unit plus 4 additional Trend Log Objects for every non-terminal unit in one or more devices on the Building Control Network Backbone IP network that support the T-VMT-E-B BIBB for later use by the site.
 - (3) A combination of these two methods is permitted provided the total required number of Trend Log Objects is met.

3.1.3.6 Trending

Perform all trending using a Niagara Framework Supervisory Gateway using Niagara Framework History Extensions and Niagara Framework History Service exclusively.

3.1.3.7 Overrides

Provide an override for each point shown on the Points Schedule as requiring an override. Use the Niagara Framework for all overrides to points in Niagara Framework Supervisory Gateways. For overrides to other points, provide an override to a point in a Niagara Framework Supervisory Gateway via the Niagara Framework where the Niagara Framework Supervisory Gateway overrides the other point as specified.

Unless otherwise approved, provide Commandable Objects to support all Overrides in non-Niagara Framework Supervisory Gateway DDC Hardware. With specific approval from the Contracting Officer, Overrides for points which are not hardware outputs and which are in DDC hardware controlling a single terminal unit may support overrides via an additional Object provided for the override. No other means of implementing Overrides may be used.

- a. Where Commandable Objects are used, ensure that WriteProperty service requests with a Priority of 10 or less take precedence over the SEQUENCE VALUE and that WriteProperty service request with a priority of 11 or more have a lower precedence than the SEQUENCE VALUE.
- b. For devices implementing overrides via additional Objects, provide Objects which are NOT Written to as part of the normal Sequence of Operations and are Writable when Out_Of_Service is TRUE and Out_Of_Service is Writable. Use this point as an Override of the normal value when Out_Of_Service is TRUE and the normal value otherwise. Note these Objects may be modified as part of the sequence via local processes, but must not be modified by local processes when Out_Of_Service is TRUE.

3.1.4 BACnet Gateways

The requirements in this paragraph do not themselves permit the installation of hardware not meeting the other requirements of this section. Except for proprietary systems specifically indicated in Section 23 09 00, all control hardware installed under this project must meet the requirements of this specification, including the control hardware providing the network interface for a package unit or split system specified under another section. Only use gateways to connect to pre-existing control devices, and to proprietary systems specifically permitted by Section 23 09 00.

3.1.4.1 General Gateway Requirements

Provide BACnet Gateways to connect non-BACnet control hardware in accordance with the following:

- a. Configure gateways to map writable data points in the controlled equipment to Writable Properties of Standard Objects, or to Niagara Framework points, as indicated in the Points Schedule and as specified.
- b. Configure gateway to map readable data points in the controlled equipment to Readable Properties of Standard Objects, or to Niagara Framework points, as indicated in the Points Schedule and as specified.
- c. Configure gateway to support the DS-COV-B BIBB for all points mapped to BACnet Objects.

- d. Do not use non-BACnet control hardware for controlling built-up units or any other equipment that was not furnished with factory-installed controls. (Note: A Niagara Framework Supervisory Gateway is BACnet control hardware.)
- e. Do not use non-BACnet control hardware for system scheduling functions.
- f. Each gateway must communicate with and perform protocol translation for non-BACnet control hardware controlling one and only one package unit or a single non-BACnet system specifically permitted by Section 23 09 00.
- g. Connect one network port on the gateway to the Building Control Backbone IP Network or to a BACnet MS/TP network and the other port to the single piece of controlled equipment or the non-BACnet system specifically permitted by Section 23 09 00..
- h. For gateways to existing package units or simple split systems, non-BACnet network wiring connecting the gateway to the package unit must not exceed 10 feet in length and must connect to exactly two devices: the controlled equipment (packaged unit) or split system interface and the gateway.

-- End of Section --

SECTION 23 09 53.00 20

SPACE TEMPERATURE CONTROL SYSTEMS
02/10, CHG 2: 08/17

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL, INC. (AMCA)

AMCA 500-D (2018) Laboratory Methods of Testing
Dampers for Rating

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING
ENGINEERS (ASHRAE)

ASHRAE FUN IP (2021) Fundamentals Handbook, I-P Edition

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.1 (2020) Gray Iron Pipe Flanges and Flanged
Fittings Classes 25, 125, and 250

ASME B16.5 (2020) Pipe Flanges and Flanged Fittings
NPS 1/2 Through NPS 24 Metric/Inch Standard

ASME B16.18 (2021) Cast Copper Alloy Solder Joint
Pressure Fittings

ASME B16.22 (2021) Wrought Copper and Copper Alloy
Solder Joint Pressure Fittings

ASME B16.26 (2018) Standard for Cast Copper Alloy
Fittings for Flared Copper Tubes

ASME B31.1 (2022) Power Piping

ASME B31.5 (2020) Refrigeration Piping and Heat
Transfer Components

ASME B40.100 (2013) Pressure Gauges and Gauge
Attachments

ASTM INTERNATIONAL (ASTM)

ASTM A126 (2004; R 2019) Standard Specification for
Gray Iron Castings for Valves, Flanges,
and Pipe Fittings

ASTM B32 (2020) Standard Specification for Solder
Metal

ASTM B75/B75M (2020) Standard Specification for Seamless

Copper Tube

ASTM B88 (2022) Standard Specification for Seamless
Copper Water Tube

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250 (2020) Enclosures for Electrical Equipment
(1000 Volts Maximum)

NEMA ST 1 (1988; R 1994; R 1997) Specialty
Transformers (Except General Purpose Type)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (2023) National Electrical Code

NFPA 90A (2021) Standard for the Installation of
Air Conditioning and Ventilating Systems

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION
(SMACNA)

SMACNA 1780 (2002) HVAC Systems - Testing, Adjusting
and Balancing, 3rd Edition

SMACNA 1966 (2020) HVAC Duct Construction Standards
Metal and Flexible, 4th Edition

U.S. FEDERAL COMMUNICATIONS COMMISSION (FCC)

FCC Part 15 Radio Frequency Devices (47 CFR 15)

UNDERWRITERS LABORATORIES (UL)

UL 508 (2018; Reprint Jul 2021) UL Standard for
Safety Industrial Control Equipment

1.2 SUBCONTRACTOR SPECIAL REQUIREMENTS

Perform all work in this section in accordance with the paragraph
SUBCONTRACTOR SPECIAL REQUIREMENTS in Section 01 30 00 ADMINISTRATIVE
REQUIREMENTS. The paragraph specifies that all contract requirements of
this section shall be accomplished directly by a first tier
subcontractor. No work required shall be accomplished by a second tier
subcontractor.

1.3 SYSTEM DESCRIPTION

Provide space temperature control systems complete and ready for operation.

1.4 SYSTEM REQUIREMENTS

Provide control systems composed of any combination of electric, analog
electronic or pneumatic devices. Indicated control system devices of a
particular type do not intend a requirement for the device unless the
requirement is specifically indicated. Requirements apply to field
installed control systems.

The Base existing control system is manufactured by Schneider Electric . Provide new equipment compatible with the existing base control system to the extent that the direct interface uses the same control signal type and level over the same calibrated range as the existing equipment.

1.5 CENTRALIZED DIRECT DIGITAL CONTROL (DDC) SYSTEMS

DDC systems are not permitted. Microprocessor-based single-loop controllers, unitary control system, variable-air-volume (VAV) boxes, and room thermostats may be used provided that the devices are manually configurable by the use of device firmware and require no software written by the Contractor for their application and use.

1.6 PERFORMANCE REQUIREMENTS

Provide control systems to maintain the required heating, ventilating, and cooling (HVAC) conditions by performing the functions and sequences of operations indicated. Control systems shall be complete, including all equipment and appurtenances, and ready for operation. Control systems shall be furnished, installed, tested, calibrated, and started up by, or under the supervision of trained technicians certified by the Contractor as qualified and regularly employed in such work. Control system equipment, valves, panels and dampers shall bear the manufacturer's nameplate.

1.7 DESIGN REQUIREMENTS

1.7.1 Control System Diagrams

For each system, indicate HVAC process flow and location of devices relative to flow and to the HVAC control panel, the connections of control devices in control loops, references of control device contacts and device operating coils to line numbers of a ladder diagram and sequencing diagrams showing the operation of valves, dampers, and contacts relative to controller output, and HVAC process variables.

1.7.2 Ladder Diagram

Indicate connections and interlocks to control system devices and other devices such as starters, drives, HVAC control system panels, and HVAC equipment panels. Diagram shall be coordinated by line number and device number with each control system diagram.

1.7.3 Operating Parameters

Indicate operating parameters for devices shown on the control system diagram such as setpoints, ranges, limits, differentials, outside air temperature schedules, contact operating points, and HVAC equipment operating time schedules.

1.7.4 Automatic Control Valve Schedules

Indicate valve size, Cv, flow rate, pressure drop, top size, spring range, positioner range, operating signal characteristics, and power source.

1.7.5 Damper Schedules

Indicate damper sizes, quantities and sizes of actuators, spring ranges, positioner ranges, operating signal characteristics, and power source.

1.7.6 Wiring Diagram

Indicate terminal blocks, wire marker identification, connections to control system devices, external and internal power sources, and connections to external devices, starters, drives, control panels, jumpers, and ground connections.

1.7.7 Compressed Air Station Schematic

Indicate compressors, motors and horsepower rating, voltage, starter, isolators, manual bypasses, tubing sizes, drain piping and drain traps, reducing valves, dryer, manufacturers' names and model numbers, mounting, access, and clearance requirements. Also include [control panel schematics](#) for pneumatic control.

1.7.8 Sequence of Operation

Sequence of operation for each HVAC control system coordinated with device identifiers on control system diagram and ladder diagram.

1.7.9 Arrangement Drawing

Arrangement diagram of each HVAC control system panel coordinated with device identifiers on the control system diagram and the ladder diagram.

1.8 SUBMITTALS

Government approval is required for submittals . Submit the following in accordance with Section [01 33 00](#) SUBMITTAL PROCEDURES:

[SD-02 Shop Drawings](#)

[Control System Diagrams](#) for each HVAC system; [G](#)

[Ladder Diagram](#); [G](#)

[Operating Parameters](#); [G](#)

[Automatic Control Valve Schedules](#); [G](#)

[Damper Schedules](#); [G](#)

[Sequence of Operation](#); [G](#)

[Arrangement Drawing](#); [G](#)

[Wiring Diagram](#); [G](#)

[Compressed Air Station Schematic](#); [G](#)

[Control Panel Schematics](#) for pneumatic control; [G](#)

[SD-03 Product Data](#)

Actuators; G

Valves; G

Dampers; G

Fire Protection Devices; G

Sensors; G

Thermostats; G

Sunshields; G

Pressure Switches; G

Indicating Devices; G

Controllers; G

Pressure Gages; G

Control Panels; G

SD-06 Test Reports

Commissioning Procedures; G

Calibration Adjustment And Commissioning Reports; G

Site Testing Procedures Identifying Each Item Tested and
Describing Each Test; G

Performance Verification Test plans and procedures; G

SD-07 Certificates

Certification of Completion; G

SD-08 Manufacturer's Instructions

Training Course Documentation; G

SD-10 Operation and Maintenance Data

Space Temperature Control System, Data Package 3; G

Submit in accordance with Section 01 78 23 OPERATION AND
MAINTENANCE DATA.

SD-11 Closeout Submittals

Qualified Service Organization List; G

1.9 QUALITY ASSURANCE

1.9.1 Standard Products

- a. Material and equipment shall be standard products of manufacturers

regularly engaged in the manufacturing of such products, using similar materials, design and workmanship. The standard products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year use shall include applications of similarly sized equipment and materials used under similar circumstances.

The 2 years experience must be satisfactorily completed by a product which has been sold or is offered for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures. Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation, for not less than 6000 hours exclusive of the manufacturer's factory tests, can be shown.

- b. The equipment items shall be supported by a service organization.

1.9.2 Nameplates and Tags

- a. Provide nameplates bearing legends as shown and tags bearing device unique identifiers as shown shall have engraved or stamped characters. Nameplates shall be mechanically attached to HVAC control panel doors.
- b. A plastic or metal tag shall be mechanically attached directly to each field-mounted device or attached by a metal chain or wire.
- c. Each airflow measurement station shall have a tag showing flow rate range for signal output range, duct size, and device identifier where shown.

1.9.3 Verification of Dimensions

Contractor shall become familiar with details of work, shall verify dimensions in the field, and shall advise Contracting Officer of any discrepancy before performing work.

1.9.4 Modification of References

Accomplish work in accordance with ASME B31.1, ASME B31.5, NFPA 70, and NFPA 90A, except as modified herein or indicated otherwise for equipment, materials, installation, examination, inspection, and testing. Consider the advisory or recommended provisions to be mandatory, as though the word "shall" had be substituted for the words "should" or "could" or "may," wherever they appear. Interpret reference to "authority having jurisdiction" and "owner" to mean the Contracting Officer.

1.9.5 Site Testing Procedures

Indicate test equipment to be used including manufacturers' names and model numbers, date of last calibration, and accuracy of calibration.

1.9.6 Commissioning Procedures

Define procedures specific to each control system including instructions on how to set control parameters and setpoints, proportional, integral and derivative mode constants, contact output settings, positioner range adjustments, and calibration checks of transmitters

1.9.7 Calibration Adjustment and Commissioning Reports

Submit specific to each HVAC control system, including settings adjustments and results of calibration checks

1.9.8 Space Temperature Control System

In addition to the requirements specified in the paragraph SUBMITTALS, meet the following requirements. Submit Operation and Maintenance Manuals for items of equipment listed under paragraph PRODUCT DATA. Manual shall contain full hardware support documentation, which shall include but not be limited to the following:

- a. General description and specifications
- b. Installation and initial checkout procedures
- c. Detailed electrical and logical description
- d. Troubleshooting procedures, diagrams, and guidelines
- e. Alignment and calibration procedures for components
- f. Preventive maintenance requirements and a maintenance checklist
- g. Detailed schematics and assembly drawings
- h. Spare parts list data, including required tool kits and suggested method of repairs such as field repair, factory repair, or item replacement
- i. Signal identification and timing diagrams
- j. Complete as-built control drawings, schedules, and sequence of operation
- k. Controller configuration and parameter setting procedures
- l. Step-by-step procedures required for each HVAC control systems startup, operation, shutdown, recovery, and fault diagnosis
- m. Manufacturer supplied operator manuals for equipment
- n. Qualified service organization list

PART 2 PRODUCTS

2.1 COMPONENTS

Provide components factory ordered for this project. Rebuilt equipment, warehoused equipment, or earlier generation equipment shall not be acceptable. Electrical, electronic, and electropneumatic devices not located within control panels shall have a NEMA 250 Type 1 enclosure in accordance with NEMA 250 unless otherwise specified. Actuators and positive positioners, and transmitters shall operate within temperature limit ratings of plus 35 to 150 degrees F. Panel mounted instruments shall operate within limit ratings of 35 to 120 degrees F and 10 percent to 95 percent relative humidity, noncondensing. Devices installed outdoors shall operate within limit ratings of minus 35 to 150 degrees F.

2.2 ACTUATORS

Provide pneumatic, electric, or electronic actuators. Actuators shall function as required within 85 to 110 percent of their power supply rating. Actuators shall fail to their spring return positions on signal or power failure unless indicated as timed, power return actuators. Actuators shall have visible position indicators. Where actuators do not have positive spring returns for fail-safe operation, provide capacity tanks, restrictors, check valves, and relays, or reserve power as required to achieve proper timed positioning for up to 4 minutes after primary power failure. Actuators shall open or close the devices to which they are applied within 60 seconds after a full scale signal input change. Pneumatic actuators shall be rated for 25 psig operating pressure except for high pressure cylinder type actuators.

2.2.1 Damper Actuators

Damper actuators shall be rated for at least 125 percent of the motive power necessary to operate the connected damper. The actuator stroke shall be limited by an adjustable stop in the direction of the return stroke. Actuators shall be provided with mounting and connecting hardware.

2.2.2 Valve Actuators

Valve actuators shall be rated for at least 125 percent of the motive power necessary to operate the valves over their full range of operation against the total and differential pressures.

2.2.3 Positive Positioners

Positive positioners shall be pneumatic relays with mechanical feedback mechanisms, adjustable operating ranges, and starting points.

2.3 AUTOMATIC CONTROL VALVES

Provide automatic control valves.

2.3.1 Valve Assembly

Valves shall have stainless steel stems and stuffing boxes with extended necks to clear the piping insulation. Valve bodies shall be designed for not less than 125 psig working pressure or 150 percent of the system operating pressure, whichever is greater. Maximum rated shutoff pressure of the valve shall exceed the rated deadhead pressure of the pump that supplies it. Valve leakage rating shall be 0.01 percent of rated Cv for soft-seated valves and 0.05 percent for metal-to-metal seated valves. Class 125 copper alloy valve bodies and Class 150 steel or stainless steel valves shall conform to ASME B16.5 as a minimum. Components of cast iron valves shall conform to ASTM A126 Class B or C as a minimum.

2.3.2 Butterfly Valve Assembly

Butterfly valves shall be threaded lug type suitable for dead-end service, and for modulation to the fully closed position, with carbon steel bodies or cast iron Class 125 and noncorrosive discs, stainless steel shafts supported by bearings, and EPDM seats suitable for temperatures from minus 20 degrees to plus 250 degrees F. Valves shall have a manual means of operation independent of the actuator.

2.3.3 Two-Way Valves

Two-way modulating valves shall have equal percentage characteristics.

2.3.4 Three-Way Valves

Three-way valves shall provide constant total flow throughout full plug travel.

2.3.5 Duct-Coil and Terminal-Unit-Coil Valves

Control valves with either flare-type or solder-type ends shall be provided for duct or terminal-unit coils. Flare nuts shall be provided for each flare-type end valve.

2.3.6 Valves for Chilled Water, Condenser Water, and Glycol Service

ASME B16.1. Bodies for valves 2 inches and smaller shall be brass or bronze, with threaded-end or union-end connections. Bodies for valves from 2.5 inches and larger shall be cast iron. Bodies for valves 2.5 inches and larger shall have flanged-end connections. Internal valve trim shall be brass or bronze except that valve stems may be Type 316 stainless steel. Water valves shall be sized for a 3 psi differential through the valve at rated flow, except as indicated otherwise. Select valve flow coefficient (Cv) for an actual pressure drop not less than 50 percent or greater than 125 percent of the design pressure drop at design flow. Valves 4 inches and larger shall be butterfly valves.

2.3.7 Valves for Hot Water Service

Valves for hot water service below 250 Degrees F shall conform to ASME B16.1. Bodies for valves 2 inches and smaller shall be brass or bronze, with threaded-end or union-end connections. Bodies for valves 2.5 inches and larger shall be cast iron. Bodies for 2.5 inches and larger shall have flanged-end connections. Water valves shall be sized for a 3 psi differential through the valve at rated flow, except as indicated otherwise. Select valve flow coefficient (Cv) for an actual pressure drop not less than 50 percent or greater than 125 percent of the design pressure drop at design flow. Internal trim, including seats, seat rings, modulating plugs, and springs, of valves controlling water hotter than 210 degrees F shall be Type 316 stainless steel. Internal trim for valves controlling water 210 degrees F or less shall be brass or bronze. Non-metallic parts of hot water control valves shall be suitable for a minimum continuous operating temperature of 250 degrees F or 50 degrees F above the system design temperature, whichever is higher. Valves 4 inches and larger shall be butterfly valves.

2.4 DAMPERS

Provide dampers in air ducts.

2.4.1 Damper Assembly

Damper shall conform to SMACNA 1966. A single damper section shall have blades no longer than 48 inches and shall be no higher than 72 inches. Maximum damper blade width shall be 8 inches. Larger sizes shall consist of a combination of sections. Dampers shall be steel or other materials where indicated. Flat blades shall be made rigid by folding the edges.

Provide blades with compressible seals at points of contact. Provide channel frames of dampers with jamb seals to minimize air leakage. Dampers shall not leak in excess of 10 cfm per square foot at 4 inches water gage static pressure when closed. Seals shall be suitable for an operating temperature range of minus 40 degrees F to 200 degrees F. Dampers shall be rated at not less than 2000 fpm air velocity. Moving parts of the operating linkage in contact with each other shall consist of dissimilar materials. Damper axles shall be 0.5 inch minimum plated steel rods supported in the damper frame by stainless steel or bronze bearings. Blades mounted vertically shall be supported by a non-ferrous dissimilar thrust bearings. Pressure drop through dampers shall not exceed 0.05 inch water gage at 1,000 fpm in the wide-open position. Frames shall not be less than 2 inches wide. Dampers shall be tested in accordance with AMCA 500-D.

2.4.2 Operating Links

Operating links external to dampers, such as crankarms, connecting rods, and line shafting for transmitting motion from damper actuators to dampers, shall withstand a load equal to at least twice the maximum required damper-operating force. Rod lengths shall be adjustable. Links shall be brass, bronze, zinc-coated steel, or stainless steel. Mating parts shall consist of dissimilar materials. Working parts of joints and clevises shall be brass, bronze, or stainless steel. Adjustments of crankarms shall control the open and closed position of dampers.

2.5 FIRE PROTECTION DEVICES

Provide smoke detectors in return and supply air ducts on the downstream side of the filters in accordance with NFPA 90A, except as otherwise indicated. Provide UL listed or FM approved detectors for duct installation.

2.5.1 Smoke Detectors

Provide in each air-handling system with supply air capacity greater than 2000 cfm in accordance with NFPA 90A. Locate downstream of the supply air filters and prior to any branch connection in accordance with NFPA 72. Provide in each air-handling system, serving more than one story, and having a return air capacity greater than 15000 cfm in accordance with NFPA 90A. Locate at each story prior to connection to common return and at return connection to air handler prior to any fresh air inlet connection and prior to any recirculation connection in accordance with NFPA 72. Smoke control and exhaust systems shall have provision for automatic and manual operation by means of a key-operated switch to override any other shutdown features and shall be located as indicated.

Provide in each air-handling system, serving more than one story, and having a return air capacity greater than 7079 L/s 15000 cfm in accordance with NFPA 90A. Locate at each story prior to connection to common return and at return connection to air handler prior to any fresh air inlet connection and prior to any recirculation connection in accordance with NFPA 72. Design for detection of abnormal smoke densities by the ionization or photoelectric principle, responsive to both invisible and visible particles of combustion, and not susceptible to undesired operation by changes to relative humidity.

Provide UL listed or FM approved detectors for duct installation. Provide duct detectors with an approved duct housing, mounted exterior to the duct, and with perforated sampling tubes extending across the width of the duct. Provide permanent descriptive zone labels indicating in which air-handling units the detectors in alarm are located.

Provide detectors with a test port , test switch and or remote keyed test device. Provide control and power modules required for operation of detectors integral with the main building fire alarm control panel. A ground fault or single break or open condition in electrical circuitry to any detector or its control or power units shall cause activation of building fire alarm control panel trouble signals.

Electrical supervision of wiring used exclusively for air-handling unit shutdown is not required provided a break in wiring would cause shutdown of the associated unit. Equipment and devices shall be compatible and operable in all respects with, and shall in no way impair reliability or operational functions of, the existing building fire alarm system.

Smoke control and exhaust systems shall have provisions for automatic and manual operation by means of a key-operated switch to override any other shutdown features and shall be located adjacent to the fire alarm system control panel .

Activation of duct detector shall cause shutdown of the associated air-handling unit and shall sound an alarm bell, with minimum 6 inch diameter, in a normally occupied area located as directed.

2.6 SENSORS

2.6.1 Spans and Ranges

Transmitters shall be calibrated to provide an electric or electronic output signal of 4 to 20 mA electric or electronic and 3 to 15 psi output for pneumatics over the indicated span or range.

- a. Conditioned space temperature, from 50 to 100 degrees F.
- b. Duct temperature, from 40 to 140 degrees F.
- c. High temperature hot-water temperature, from 200 to 500 degrees F.
- d. Chilled water temperature, from 30 to 80 degrees F.
- f. Heating hot water temperature, from 100 to 250 degrees F.
- g. Condenser water temperature, from 30 to 130 degrees F.
- h. Outside air temperature, from minus 30 to 130 degrees F.
- i. Relative humidity, from 0 to 100 percent for high/low limit applications; from 20 to 80 percent for space applications.
- j. Differential pressure for VAV supply duct static pressure from 0 to 2.0 inches water gage.
- k. Pitot tube airflow measurement station and transmitter, from 0 to

0.1 inch water gage for flow velocities of 500 to 1200 fpm, 0 to 0.25 inch water gage for velocities of 500 to 1800 fpm, or 0 to 0.5 inch water gage for velocities of 500 to 2500 fpm, or 0 to 1.5 inches water gage for velocities of 1500 to 4500 fpm, or 0 to 2 inches water gage for velocities of 3000 to 6000 fpm as required by the duct system.

o 2500 fpm, 1500 to 4500 fpm, or 3000 to 6000 fpm as required by the duct system.

2.6.2 Temperature Sensors

2.6.2.1 Resistance Temperature Detectors (RTD's)

RTD shall be platinum with a tolerance of plus or minus 0.25 percent at 32 degrees F, and shall be encapsulated in epoxy, Series 300 stainless steel, anodized aluminum, or copper. RTD shall be furnished with RTD transmitter as specified, integrally-mounted unless otherwise indicated.

2.6.2.2 Continuous Averaging RTD's

Continuous averaging RTD's shall have a tolerance of plus or minus 1.0 degrees F at the reference temperature, and shall be of sufficient length to ensure that the resistance represents an average over the cross section in which it is installed. Sensing element shall have a bendable copper sheath. Averaging RTD shall be furnished with RTD transmitter as specified, to match the resistance range of the averaging RTD. Element length shall be a minimum of one linear foot per square foot of coil face area.

2.6.2.3 RTD Transmitter

RTD transmitter shall be selected to match the resistance range of the RTD. Transmitter shall be a two-wire, loop-powered device. Transmitter shall produce a linear 4 to 20 mA dc output corresponding to required temperature measurement. Output error shall not exceed 0.1 percent of the calibrated measurement. Transmitter shall include offset and span adjustments.

2.6.3 Relative Humidity Instruments

2.6.3.1 Relative Humidity Sensor

Provide relative humidity sensor. Use nonsaturating sensing elements capable of withstanding a saturated condition without permanently affecting calibration or sustaining damage. Sensing elements shall be bulk polymer or thin film polymer. Sensing elements shall have an accuracy of plus or minus 2 percent of full scale within the range of 20 to 80 percent relative humidity. Provide a two-wire, loop-powered transmitter located at the sensing elements to convert the sensing elements output to a linear 4 to 20 mA dc output corresponding to required humidity measurement. Output error shall not exceed 0.1 percent of calibrated measurement. Transmitter shall include offset and span adjustments. Transmitter shall have ability to be calibrated electronically by using a one-point, in-situ method which allows for error correction with a single potentiometer.

2.6.4 Dew Point Instruments

Provide analog salt-phase transition or dual chilled, mirror type sensor. Sensor shall have an allowable deviation of plus or minus 3 degrees F dew point over the range of 10 to 80 degrees F dew point.

2.6.5 Airflow Sensors

Provide airflow sensors.

2.6.5.1 Electronic Airflow Measurement Stations and Transmitters

- a. Stations shall contain an array of velocity sensing elements and straightening vanes inside a flanged sheet metal casing. Velocity sensing elements shall be RTD or thermistor type, with linearizing means. Sensing elements shall be distributed across the duct cross section in the quantity and pattern set forth for measurements and instruments in accordance with ASHRAE FUN IP and SMACNA 1780, for traversing of ducted airflows. Resistance to airflow through the airflow measurement station shall not exceed 0.08 inch water gage at airflow of 2000 fpm. Station construction shall be suitable for operation at airflows of up to 5000 fpm over a temperature range of 40 to 120 degrees F, and accuracy shall be plus or minus 3 percent over a range of 125 to 2500 fpm scaled to air volume. Use stations if required velocity measurement is below 500 feet per minute.
- b. Transmitters shall produce a linear, temperature compensated 4 to 20 mA dc output corresponding to required velocity pressure measurement. Transmitters shall be a two-wire, loop-powered device. Output error of transmitters shall not exceed 0.5 percent of calibrated measurement. Transmitters shall have offset and span adjustments.

2.6.5.2 Pitot Tube Airflow Measurement Stations and Transmitters

- a. Stations shall contain an array of velocity sensing elements and straightening vanes inside a flanged sheet metal casing. Velocity sensing elements shall be multiple pitot tube type with averaging manifolds. Sensing elements shall be distributed across the duct cross section in the quantity and pattern set forth for measurements and instruments in accordance with ASHRAE FUN IP or SMACNA 1780, for traversing of ducted airflows. Resistance to airflow through the airflow measurement station shall not exceed 0.08 inch water gage at airflow of 2000 fpm. Station construction shall be suitable for operation at airflows of up to 5000 fpm over a temperature range of 40 to 120 degrees F, and accuracy shall be plus or minus 3 percent over a range of 500 to 2500 fpm scaled to air volume. Do not use stations if required velocity measurement is below 500 feet per minute.
- b. Transmitters shall produce a linear 4 to 20 mA dc output corresponding to the required velocity pressure measurement. Each transmitter shall have a low-range differential pressure sensing element and a square root extractor. The transmitter shall be a two-wire, loop powered device. Sensing element accuracy shall be plus or minus 1 percent of full scale, and overall transmitter accuracy shall be plus or minus 0.25 percent of the calibrated measurement. Each transmitter shall have offset and span

adjustments.

2.6.6 Pressure Sensors

Provide electronic pressure sensor and transmitter. Sensor shall be a pressure transmitter with an integral sensing element. Sensor over pressure rating shall be 25 psig above its normal operating range. Sensing element accuracy shall be plus or minus one percent of full scale. Transmitter accuracy shall be plus or minus 0.1 percent of the calibrated measurement. Transmitter shall be a two-wire, loop-powered device. Transmitter shall produce a linear 4 to 20 mA dc output corresponding to required pressure measurement. Transmitter shall have offset and span adjustments.

2.7 THERMOWELLS

Provide brass or Series 300 stainless steel thermowells with threaded brass plug and chain, 2 inch lagging neck and extension type well, and inside diameter and insertion length as required for the application. Provide thermowells for immersion sensors with conducting material inside the well.

2.8 THERMOSTATS

Provide thermostats.

2.8.1 Ranges

Thermostat ranges shall be selected so that the setpoint is adjustable without tools between plus or minus 10 degrees F of the setpoint indicated.

2.8.2 Nonmodulating Electric Room Thermostats

Contacts shall be single-pole double-throw (SPDT), hermetically sealed, and wired to identified terminals. Maximum differential shall be 2 degrees F. Thermostat covers shall consist of locking metal or heavy-duty plastic, and shall be capable of being locked by an Allen wrench or special tool. Thermostats shall have manual switches as required by the application and a minimum range of 55 to 90 degrees F.

2.8.3 Microprocessor-Based Room Thermostats

Microprocessor-based room thermostats shall have built-in keypads for scheduling of day and night temperature settings. Access to the scheduling mode shall be by password control code. When out of the scheduling mode, thermostats shall have continuous 12-hour time display, with AM and PM indication, continuous display of day of the week, and either continuous display of room temperature with display of temperature setpoint on demand, or continuous display of temperature setpoint with display of room temperature on demand. In the programmable mode, use the display for setting and interrogating time program ON-OFF setpoints for each day of the week. The time program shall allow two separate temperature setback intervals per day. Thermostats shall have a means for temporary and manual override of program schedule, with automatic program restoration on the following day. Thermostats shall have a replaceable battery to maintain timing and to maintain the schedule in memory for one year in the event of a power outage. Maximum differential shall be 2 degrees F. Where used for heat pump applications, thermostat shall have an emergency heat switch.

2.8.4 Low-Temperature Protection Thermostats (Freezestats)

Low-temperature protection thermostats shall be manually reset low-temperature safety thermostats, with NO and NC contacts or a two-position pneumatic output signal and a 20 foot element which shall respond to the coldest 18 inch segment.

2.8.5 Modulating Capillary Thermostats

Thermostats shall have either one output signal, two output signals operating in unison, or two output signals operating in sequence, as required for the application. Thermostats shall have adjustable throttling ranges of 4 to 8 degrees F for each output.

2.8.6 Modulating, Insertion, Immersion, & Averaging Pneumatic Thermostats

Thermostats shall be two-pipe, pilot-operated type with pneumatic feedback, proportional action and shall have an adjustable throttling range of 2 to 100 degrees F with a minimum range of 10 to 250 degrees F. Averaging elements shall be 1 foot in length for each 4 square feet of ductwork cross-sectional area with a minimum length of 8 feet.

2.9 SUNSHIELDS

Provide sunshields for outside air temperature sensing elements to prevent the sun from directly striking temperature sensing elements. Provide sunshields with adequate ventilation so that the sensing element responds to the ambient temperature of surroundings. The top of each sunshield shall have galvanized metal or aluminum rainshield projecting over the face of the sunshield. Sunshields shall be painted white or shall be unpainted aluminum.

2.10 PRESSURE SWITCHES AND SOLENOID VALVES

Provide pressure switches and solenoid valves.

2.10.1 Pressure Switches

Switches shall have an adjustable setpoint with visible setpoint scale. Range shall be as indicated. Differential adjustment shall span 20 to 40 percent of the range of the device.

2.10.2 Differential Pressure Switches

Switches shall be an adjustable diaphragm-operated device with two SPDT contacts, with taps for sensing lines to be connected to duct pressure fittings designed to sense air pressure. Fittings shall be angled-tip type with tips pointing into the airstream. Range shall be 0.5 to 6 inches water gage. Differential shall be a maximum of 0.15 inch water gage at the low end of the range and 0.35 inch water gage at the high end of the range.

2.11 INDICATING DEVICES

Provide indicating devices.

2.11.1 Thermometers

- a. Thermometers for insertion in ductwork and piping systems shall have brass, malleable iron, or aluminum alloy case and frame, clear protective face, and permanently stabilized glass tube with an indicating fluid column, white face, black numbers, and a 9 inch scale.
- b. Thermometers for piping systems shall have rigid stems with straight, angular, or inclined pattern.
- c. Thermometer stems shall have expansion heads as required to prevent breakage at extreme temperatures. On rigid stem thermometers, the space between bulb and stem shall be filled with a heat transfer medium.
- d. Air duct thermometers shall have perforated stem guards and 45 degree adjustable duct flanges with locking mechanisms.
- e. Averaging thermometers shall have 3.5 inch (nominal) dial, with black legend on white background, and pointer traveling through a 270 degree arc.
- f. Thermometers shall have an accuracy of plus or minus one percent of scale range. Thermometers shall have the following ranges:
 - (1) Mixed air temperature: 0 to 100 degrees F in 1 degree F graduations.
 - (2) Return air temperature: 0 to 100 degrees F in 1 degree F graduations.
 - (3) Cooling coil discharge temperature: 0 to 100 degrees F in 1 degree F graduations.
 - (4) Heating coil discharge temperature: 30 to 180 degrees F in 2 degree F graduations.
 - (5) Hydronic heating systems below 220 degrees F: 40 to 240 degrees F in 2 degree graduations.
 - (6) Chilled water temperature: 0 to 100 degrees F in one degree F graduations.
 - (7) Condenser water temperature: 40 to 140 degrees in one degree F graduations.
 - (8) Glycol temperature: 0 to 100 degrees F for cooling service in one degree F graduations, and 40 to 240 degrees F for heating service in 2 degree F graduations.
 - (9) High temperature hot water: 100 to 550 degrees F in 5 degree F graduations.

2.11.2 Pressure Gages

Provide pressure gages with gage cock, snubber, and syphon.

- a. ASME B40.100. Gages shall be 2 1/2 inch (nominal) size,

back-connected, suitable for field or panel mounting as required, shall have black legend on white background, and shall have a pointer traveling through a 270 degree arc. Accuracy shall be plus or minus 3 percent of scale range.

- b. Gages for indicating signal output to pneumatic actuators and main air gages shall have scale of 0 to 30 psig in 1 psig graduations.
- c. Gages for air storage tanks and for use before and after dirt and oil filters or dryers, shall have a scale of 0 to 160 psig with 2 psig graduations.
- d. Gages for hydronic system applications shall have ranges and graduations as indicated.
- e. Pneumatic transmission receiver gages shall have a range to match the respective transmitters.

2.12 LOW-DIFFERENTIAL PRESSURE GAGES

Gages for low-differential pressure measurements shall be 4 1/2 inch (nominal) size with two seats of pressure taps, and shall have a diaphragm-actuated pointer, white dial with black figures, and pointer zero adjustment. Gages shall have ranges and graduations as indicated. Accuracy shall be plus or minus 2 percent of scale range.

2.13 CONTROLLERS

2.13.1 Single-Loop Controllers

2.13.1.1 Controller Features

Controller shall be a microprocessor-based, single-loop device that does not require Contractor-generated software. Controller shall conform to FCC Part 15. Controller panel cutout shall be 3.62 by 3.62 inches. Controller shall have field selectable range for process variables, a remote setpoint analog input and analog output with adjustable high and low end limits, and proportional control manual reset adjustment. Analog output shall result from PID control. Analog output shall be configurable as direct acting and reverse acting. Controller shall have keyboard, display, auto/manual selection for control of analog output, and remote setpoint adjustment/local setpoint adjustment selection. Controller shall have adjustable high-end and low-end limits, ratio, and bias adjustments on remote setpoint input; operator initiated self-tune/manual-tune selection, anti-reset wind-up feature, and two configurable independent SPDT with adjustable system contact closure outputs. Controller shall be configurable to power-up in manual with local setpoint control, in automatic with local setpoint control, and in automatic with remote setpoint control. Contact closures shall be activated by a process variable and by a process variable deviation from setpoint as configured. The range of hysteresis adjustment shall not be smaller than 1 percent to 5 percent of process variable input span. Controller shall power the analog output loop to 20 mA where connected to a load of 600 ohms. Controller shall have 5-year battery backup or shall have nonvolatile memory to store operating parameters.

2.13.1.2 Controller Parameter Input and Display

Control parameters shall be entered and displayed directly, in the correct

engineering units, through a series of keystrokes on a front panel display with a 3 1/2-digit, seven-segment display, with decimal point and polarity indication. Use of the display shall allow manual interrogation of setpoint, mode constants, and values of process variables and outputs.

2.13.1.3 Controller Electrical Requirements

Controller shall be powered by 120 Vac. Controller shall provide electrical noise isolation, not less than 100 dB at 60 Hz common mode rejection ratio, and not less than 60 dB at 60 Hz normal mode rejection ratio between ac power line and process variable input, remote setpoint input, and output signals.

2.13.1.4 Controller Accuracy

Controller shall have an accuracy of plus or minus 0.30 percent of input span, plus or minus one digit.

2.13.1.5 Controller Self Tuning

Controller self-tuning operation shall apply proportional, integral, and derivative modes of control; mode constants shall be modified as required. Self tuning shall only operate when selected from the front panel.

2.13.1.6 Controller Manual Tuning

Controller manual tuning operation shall provide proportional, integral, and derivative control modes, or any combination thereof, by means of individual mode constant adjustments. Adjustments shall be set for the appropriate value if a particular control mode action is desired, or to zero for the particular mode not desired. The proportional mode constant shall be adjustable from 0 to 200 percent of input signal range; the integral mode constant shall be adjustable from 0 to 20 repetitions per minute; and the derivative mode constant shall be adjustable from 0 to 5 minutes.

2.13.2 Analog Electronic Controllers

Controllers shall be solid-state electronic devices which sense the difference between input sensor analog values (resistance or voltage) and setpoint adjustment analog values (resistance or voltage), and shall amplify the difference signal to provide the output signal. Controllers shall include the following:

- a. Proportional band: 2.5 to 33 percent of input device span.
- b. Authority: minimum of 33 to 200 percent.
- c. Inputs: thermistor, resistance, transmitter, or output of other electronic controllers.
- d. Outputs: within the range of minus 5 to 20 Vdc or a 4 to 20 mA dc current loop.
- e. Remote setpoint adjustment (SPA): plus or minus 10 percent of input device span.

2.13.3 Unitary Control Systems

Unitary control systems shall be energy-efficient, micro-processor-based temperature controllers and associated devices that do not require Contractor-generated software. Provide control systems with **integral or remote** sensor as indicated. Controllers shall operate heating, cooling, and ventilating modes with independent occupied and unoccupied settings for each of 7 consecutive days. Cooling shall be controlled in two steps and heating shall be controlled in two steps with modulating control provided for the ventilation mode. Provide temperature changeover control to limit the ventilation mode when outdoor air temperature is not sufficiently low for "free-cooling." Provision shall be made for manual changeover between heating and cooling modes, providing a one minute minimum time delay between the start and stop operation of heating and cooling stages upon startup and after power failure to prevent short cycling and power surges. Provide an optimum startup program to minimize warm-up or cool-down periods prior to the occupied mode. Outside air dampers shall be closed during the optimum startup program unless outside air is beneficial for cool-down in lieu of mechanical cooling. Fan shall operate continuously during the occupied mode and shall cycle during the unoccupied mode for heating or cooling. Provide battery backup to retain programs and maintain clock operation for 48 hours minimum during power outages. Controller shall have a self-diagnostic program to indicate errors and locking covers to prevent unauthorized program entries. Provide a convenient means to restore the occupied mode of operation for a minimum 2-hour period without removing covers. An indexing switch shall allow operation in a continuous unoccupied mode during abnormal periods without changing normal programs. Servicing tool required to place the unitary control system in use shall be a hand-held device used to adjust and monitor setpoints, controlled device positions, input sensor values, and other control system parameters.

2.14 CONTROL DEVICES AND ACCESSORIES

Provide control devices and accessories.

2.14.1 Function Modules

Function modules shall accept mA dc analog input signals to produce analog output signals or contact output signals. Modules shall have zero and span adjustments for analog outputs, and setpoint adjustments for contact outputs.

2.14.1.1 Minimum Position Switches and Temperature Setpoint Devices

Minimum position switches and temperature setpoint devices shall accept manual input and shall produce steady analog output. Switches and devices shall be suitable for recessed wall mounting or panel mounting and shall have a graduated dial.

2.14.1.2 Signal Inverter Modules

Signal inverter modules shall accept analog input signal and produce analog output signal that linearly reverses the direction of signal change of input versus output.

2.14.1.3 High-Low Signal Selector Modules

High-low signal selector modules shall accept analog input signals and

select either the highest or the lowest input signal as the output signal.

2.14.1.4 Sequencer Modules

Sequencer modules shall provide fixed time delayed sequencing of one or more contact transfers from an analog input signal. Sequencers shall return contacts to their zero input signal condition when power is interrupted.

2.14.2 Relays

Relays shall be two-pole, double-throw (DPDT) with a 10-ampere resistive rating at 24 Vac, and shall have an enclosed coil. Provide with a light indicator which is lit when the coil is energized and is not lit when the coil is not energized.

2.14.3 Time-Delay Relays

Time-delay relays shall be DPDT with octal connectors and dust covers. The adjustable timing range shall be 0 to 3 minutes .

2.14.4 Time Clocks

Time clocks shall be a 24-hour, 365-day programmable timing device with two independently timed circuits. Clocks shall have a manual scheduling keypad and alphanumeric display of timing parameters. Timing parameters shall include Gregorian calendar date for month, day and day-of-month indication; and 24-hour time-of-day display, with one-minute resolution for programming the ON and OFF times for each circuit. Circuits shall have programmable timed override from 1 to 99 minutes. Clocks shall have capacity for programming four ON events and four OFF events for each circuit. Programmed events shall be assignable to a 365-day schedule. Clocks shall have automatic standard time and daylight saving time adjustments, keyed to input of appropriate dates. Provide clocks with 4-day battery backup.

2.14.5 Override Timer

Override timers shall be manually set, mechanically driven timers, or electronic timers, without a "hold" feature. Time intervals shall be selectable for up to 12 hours of operation and shall expire unless reset.

2.14.6 Regulated Power Supplies

Power supplies shall provide a 24-Vdc linear supply at not less than 2 amperes, with regulation to 0.05 percent of output voltage. Power supplies shall have a fused input, and shall be protected from voltage surges and power-line transients. Power supply output shall be protected against overvoltage and short circuits. Power supply loading shall not be greater than 1.2 amperes.

2.14.7 Transformers

UL 508 and NEMA ST 1 as applicable. Transformers, other than transformers in bridge circuits, shall have primaries wound for available voltage and secondaries wound for correct control circuit voltage. Transformers shall be sized so that connected loads equal 80 percent of rated capacity. Transformers shall be enclosed in rustproof, galvanized steel cabinets with conduit connections. Disconnect switch shall be provided on

the primary side, and a fuse cutout on the secondary side. as indicated, provide backup power supply including transformers connected to the emergency power source .

2.14.8 Pilot Lights and Manual Switches

Device illumination shall be by light-emitting diode (LED) or neon lamp. Switches shall have operating levers and index plates showing switch positions and names of apparatus controlled or other appropriate designations.

2.15 HVAC SYSTEM CONTROL PANELS

Provide HVAC system control panels.

2.15.1 Panel Assembly

Panel shall be fabricated for bottom entry connection for control system electric power, control system main air source, control system wiring, pneumatic tubing, interconnection of control systems, interconnection of starters, and external shutdown devices. Panel shall have an operating temperature rise of not greater than 20 degrees F above an ambient temperature of 100 degrees F.

2.15.2 Panel Electrical Requirements

Control panel shall be powered by nominal 120 Vac terminating at panel on terminal blocks. Instrument cases shall be grounded. Interior and exterior panel enclosures shall be grounded.

2.15.3 Enclosures

Enclosures for each panel shall be a single door, wall-mounted box conforming to NEMA 250 with a continuous hinged and gasketed exterior door with a print pocket, key lock, and interior back panel. Inside finish shall be white enamel, and outside finish shall be gray primer over phosphatized surfaces.

2.15.4 Mounting and Labeling

Provide pilot lights, switches, panel-mounted control devices, and pressure gages shall be mounted on the door. Power conditioners, fuses, and duplex outlets shall be mounted on the interior of the cabinet. Other components housed in the panel shall be mounted on the interior back panel surface of the enclosure and shall be identified by plastic or metal nameplates which are mechanically attached to the panel. Lettering shall be cut or stamped into the nameplate to a depth of not less than 1/64 inch, and shall have contrasting color, produced by filling with enamel or lacquer or by use of laminated material. Painting of lettering directly on the surface of the door or interior back panel is not permitted.

2.15.5 Wiring and Tubing

- a. Pneumatic device inputs and outputs shall be piped to bulkhead fittings in the bottom of the panel with a 2 inch loop to facilitate replacement. Electric, electronic, and electropneumatic device signals entering and leaving the panel shall be wired to identified terminal blocks.

- b. Wiring shall be installed in wiring ducts so that devices can be added or replaced without disturbing existing wiring that is not affected by the change. Wiring to single-loop controllers shall have a 4 inch wiring loop in the horizontal wiring duct at each wiring connection. There shall be no wiring splices within the control panel. Interconnections required for power or signals shall be made on device terminals, if available, or panel terminal blocks, with not more than two wires connected to each terminal.
- c. Instrument signal grounds at the same reference level shall end at a grounding terminal connected to a common ground point for that level. Wiring shield grounds at the same reference level shall end at a grounding terminal connected to a common ground point for that level. Grounding terminal blocks shall be identified by reference level.
- d. Wiring connected to controllers shall be identified by function and polarity, e.g., process variable input and remote setpoint input and output.

2.16 CONTROL TUBING AND WIRING

Provide HVAC control tubing and wiring.

2.16.1 Tube and Fittings

2.16.1.1 Copper Tubing

ASTM B75/B75M or ASTM B88. Tubing 0.375 inch outside diameter and larger shall have a minimum wall thickness equal to ASTM B88, Type M. Tubing less than 0.375 inch outside diameter shall have a minimum wall thickness of 0.025 inch. Concealed tubing shall be hard or soft copper; multiple tubing shall be racked or bundled. Exposed tubing shall be hard copper; rack multiple tubing. Tubing for working pressures greater than 30 psig shall be hard copper. Bundled tubing shall have each tube numbered each six feet minimum. Racked and individual tubes shall be permanently identified at each end. Fittings shall be solder type ASME B16.18 or ASME B16.22, using ASTM B32, Plumbing Code approved lead-free solder, or compression type ASME B16.26.

2.16.2 Wiring

- a. Terminal blocks shall be insulated, modular, feed-through, clamp style with recessed captive screw-type clamping mechanisms. Terminal blocks shall be rail mounted, and shall have end plates, partition plates or enclosed sides for separation.
- b. Control wiring for 24-V circuits shall be 18 AWG minimum and shall be rated for 300-V service.
- c. Wiring for circuits operating at more than 100 V shall be 14 AWG minimum and shall be rated for 600-V service.
- d. Analog signal wiring circuits within control panels shall not be less than 20 AWG and shall be rated for 300-V service.
- e. Instrumentation cable shall be 18 AWG, stranded copper, single or multiple twisted, minimum 2-inch lay of twist, 100 percent shielded pairs, and shall have 300-V insulation. Each pair shall

have a 20-AWG tinned copper drain wire, individual pair, and overall insulation. Cables shall have an overall aluminum polyester or tinned overall copper cable shield tape, 20-AWG tinned-copper cable drain wire, and overall cable insulation.

- f. Nonconducting wiring ducts in control panels shall have slotted side snap-on covers, fittings for connecting ducts, mounting clips for securing ducts, and wire retaining clips.

PART 3 EXECUTION

3.1 INSTALLATION

Perform installation under the supervision of competent technicians regularly employed in the installation of control systems. Provide components for a complete and operational control system. Provide control system complete and ready for operation, as specified and indicated. Provide dielectric isolation where dissimilar metals are used for connection and support. Penetrations through and mounting holes in the building exterior shall be watertight. Control system installation shall provide adequate clearance for control system maintenance by maintaining access spaces between coils, to mixed-air plenums, and as required to calibrate, remove, repair, or replace control system devices. Control system installation shall not interfere with the clearance requirements for mechanical and electrical system maintenance. Install devices mounted in or on piping or ductwork, on building surfaces, in mechanical and electrical spaces, or in occupied space ceilings in accordance with manufacturer's recommendations and as indicated on contract documents. Provide control devices to be installed in piping and ductwork with required gaskets, flanges, thermal compounds, insulation, piping, fittings, and manual valves for shutoff, equalization, purging, and calibration. Certify that installation of control system is complete and technical requirements of this section have been met.

3.1.1 Sensors

Provide sensors in locations to sense the appropriate condition. Install sensor and transmitter where easily accessible and serviceable without special tools. Sensors shall be calibrated to the accuracy specified in the contract, and operate correctly when installed. Do not install sensors designed for one application in the place of another application (e.g., replacing a duct sensor with a room sensor).

3.1.1.1 Room Sensors

Provide on interior walls to sense average room conditions. Avoid locations which may be covered by office furniture. Do not mount room sensors on exterior walls if other locations are available. Mount centerline of sensor 5 feet above finished floor.

3.1.1.2 Duct Temperature Sensors

Provide sensors in ductwork in general locations as indicated. Select specific sensor location within duct to accurately sense appropriate air temperatures. Locate sensor connection boxes in position not obstructed by ducts or equipment. Install gaskets between sensor housing and duct wall. Seal duct and insulation penetrations. Install duct averaging sensors between two rigid supports in serpentine position to sense average conditions. Sensor shall have a total minimum length of one linear foot

per 4 square feet of duct area. Sensor shall be mounted a minimum of 3 inches from outside wall surface. Thermally isolate temperature sensing elements from supports. Provide duct access doors to averaging sensors.

3.1.1.3 Immersion Temperature Sensors

Provide thermowells for sensors measuring temperatures in liquid applications or pressure vessels. Locate wells to sense continuous flow conditions. Do not install wells using extension couplings. Where piping diameters are smaller than the length of the wells, provide wells in piping at elbows to effect proper flow across entire area of the well. Wells shall not restrict flow area to less than 70 percent of pipe area. Increase piping size as required to avoid restriction. Temperature sensors shall be installed in thermowells with thermal transmission material to speed the response of temperature measurement. Provide thermowells with sealing nuts to contain thermal transmission material.

3.1.1.4 Strap-on Temperature Sensors

Strap-on temperature sensors, using helical screw stainless steel clamps, shall be permitted on new hot water piping for on-off operation, and for existing hot water piping sizes not greater than 3 inches. Clean the pipe to bright metal. Insulate strap-on bulb and pipe after installation. Provide other liquid temperature sensors with thermowells. Provide NEMA 250 Type 4 enclosures for outdoor installations. Provide brushed aluminum or brushed stainless steel enclosures for sensors located in finished spaces.

3.1.1.5 Outside Air Temperature Sensors

Provide outside air temperature sensor on north side of building, away from exhaust hoods, air intakes, and other areas which may affect temperature readings. Install sunshields to protect outside air temperature sensor from direct sunlight.

3.1.1.6 Low-Temperature Protection Thermostats (Freezestats)

Provide thermostat for each 80 square feet of coil-face area to sense the temperature at location indicated. Install thermostat sensing element in serpentine pattern.

3.1.2 Thermometers

Provide thermometers which are installed in liquid systems in thermowells with thermal transmitting materials within the well to speed the response of temperature measurement.

3.1.3 Pressure Sensors

3.1.3.1 Duct Static Pressure

Duct static pressure sensor shall be located where indicated on drawings. If no location is indicated, it should be located approximately two-thirds of distance from supply fan to the end of duct with greatest pressure drop.

3.1.4 Pressure Gages

Provide snubbers for gages in piping systems subject to pulsation. Gages for steam service shall have pigtail fittings with cocks. Install

pressure gages at locations indicated. Pneumatic output lines shall have pressure gages mounted near the control panel.

3.1.5 Valves

Provide valve with stems upright where possible but with stems not lower than horizontal. Provide positioners where indicated and where necessary to prevent overlap of heating and cooling where one controller operates more than one pneumatic device and to maintain the proper dead band between heating and cooling.

3.1.6 Damper Actuators

Provide damper actuators so that the damper sealing action is smooth and sufficient to maintain leakage at or below specified leakage rate. Multiple actuators operating a common damper shall be connected to a common drive shaft. Provide positioners where indicated and where necessary to prevent overlap of heating and cooling where one controller operates more than one pneumatic device and to maintain the proper dead band between heating and cooling.

3.1.7 Access Doors

Provide access doors in ductwork to service airflow monitoring devices, devices with averaging elements, and low-temperature protection thermostats (freezestats).

3.1.8 Wiring

- a. Provide wiring external to control panels, including low-voltage wiring, in metallic raceways. Install wiring without splices between sensors, transmitters, control devices, and HVAC control panels. Install instrumentation grounding as necessary to prevent ground loops, noise, and surges adversely affecting operation of the system. Tag cables, conductors, and wires at both ends, with identifiers indicated on shop drawings.
- b. Other electrical work shall be specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Provide step-down transformers where control equipment operates at lower than line circuit voltages. Transformers serving individual heating, ventilating, and air-conditioning units shall be fed from fan motor leads, or fed from the nearest distribution panelboard or motor control center, using circuits provided for that purpose.
- c. Ground control panels and cabinets as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Grounding of the green ac ground wire at the breaker panel alone is not adequate. Install ground wire from each control panel to adequate building ground.

3.1.9 Foundations and Housekeeping Pads

Provide 3 inch high concrete foundations and housekeeping pads for the HVAC control system air compressors.

3.1.10 Control Drawings

Post laminated copies of as-built control system drawings in each mechanical room.

3.2 ADJUSTMENTS

Calibrate instrumentation and controls, and verify specified accuracy using test equipment traceable to National Institute for Science and Technology (NIST) standards. Adjust controls and equipment to maintain conditions indicated, to perform the functions indicated, and to operate in the sequence specified.

3.3 FIELD QUALITY CONTROL

- a. Demonstrate compliance of HVAC control systems. Furnish personnel, equipment, instrumentation, and supplies necessary to perform calibration and site testing. Calibrate test equipment in accordance with NIST standards. Ensure that tests are performed or supervised by competent employees of the control system installer or the control system manufacturer regularly employed in testing and calibration of control systems.
- b. Testing shall include field tests and the performance verification test. Field tests shall demonstrate proper calibration of instrumentation, input and output devices, and operation of specific equipment. The performance verification test shall ensure proper execution of sequence of operation and proper tuning of control loops.
- c. The plan for each phase of field acceptance testing shall be approved in writing before beginning that phase of testing. Furnish written notification of planned testing to Contracting Officer at least 21 days prior to testing. Include proposed test procedures with notification. The Contractor will not be allowed to start testing without written Government approval of test procedures. Test procedures shall consist of detailed instructions for complete testing to prove the performance of heating, ventilating, and air-conditioning system and control system. Include the following tests in test procedures.
- d. Submit original copies of data produced, including results of each test procedure, to the Government at the conclusion of each phase of testing. Tests are subject to supervision and approval by Contracting Officer. Do not perform testing during scheduled seasonal off-periods of heating and cooling systems.

3.3.1 Test Reporting

After completion or termination of field tests and again after the performance verification test, identify, determine causes, replace, repair, or calibrate equipment which fails to meet the specification; and deliver a written report to the Government. The report shall document test results, explain in detail the nature of each failure, and corrective action taken. After delivering the performance verification test report, the Contractor shall convene a test review meeting at the job site to present results and recommendations to the Government. As a part of the test review meeting, the Contractor shall demonstrate by performing appropriate portions of field tests or the performance verification test that failures have been corrected. Based on Contractor's report and test review meeting, the Government will determine either the restart point or successful completion of testing. Do not commence required retesting until after receipt of written notification by the Government. At the

conclusion of retesting, repeat the assessment.

3.3.2 Contractor's Field Testing

Calibrate field equipment and verify equipment and system operation before system is placed on-line. Include the following tests in field testing.

3.3.2.1 Tubing and Wiring Integrity Tests

Test tubing system pneumatically at 1.5 times the design working pressure for 24 hours. Allowable leakage rate is that which produces a pressure drop 1 psig in 24 hours with compressed air supply turned off. Test wiring for continuity, ground faults, and open and short circuits.

3.3.2.2 System Inspection

Observe HVAC control system in shutdown condition. Check dampers and valves for proper normal positions. Document positions for the performance verification test report.

3.3.2.3 Calibration Accuracy and Operation of Input Test

Verify correct calibration and operation of input instrument. For each sensor and transmitter, including for temperature, pressure, relative humidity, and dew point inputs, record the reading at the sensor or transmitter location using calibrated test equipment. Record the output reading provided by that sensor or transmitter. Document each of these location and output readings for the performance verification test report. The test equipment shall have been calibrated within one year of the date of use in the field. Test equipment calibration shall be traceable to the measurement standard of the National Institute of Standards and Technology.

3.3.2.4 Operation of Output Test

Check the operation of output to verify correct operation. Operate analog device to minimum range (e.g., 4 mA) and maximum range (e.g., 20 mA), and measure and record actual output values.

3.3.2.5 Actuator Range Adjustment

With the controller, apply a control signal to each actuator and verify that the actuator operates properly from its normal position through to the full range of stroke position. Record actual spring ranges and normal positions for modulating control valves and dampers.

3.3.3 Coordination With HVAC System Balancing

Tune the control system after air and hydronic systems have been balanced, minimum damper positions have been set, and a report has been issued.

3.3.4 Field Test Documentation

Before scheduling the performance verification test, provide field test documentation and written [certification of completion](#) to Contracting Officer and the Naval Energy and Environmental Support Activity (NEESA), that the installed system has been calibrated, tested, and is ready to begin the performance verification test. Do not start the performance verification test prior to receiving written permission from the

Government.

3.3.5 Performance Verification Test

Conduct the performance verification tests to demonstrate that the control system maintains setpoints and that the control loops are tuned for the correct sequence of operation. Conduct the performance verification test during one week of continuous HVAC and control systems operation and before final acceptance of work. Specifically, the performance verification test shall demonstrate that the HVAC system operates properly through the complete sequence of operation (e.g., seasonal, occupied and unoccupied, warm up, etc.), for specified control sequences. Demonstrate proper control system response for abnormal conditions for which there is a specified system or controls response by simulating these conditions. Demonstrate that hardware interlocks and safety devices work as designed. Demonstrate that the control system performs the correct sequence of control.

3.3.6 Opposite Season Test

Repeat the performance verification test during an opposite season to the first performance verification test.

3.4 TRAINING

Provide a qualified instructor to conduct training courses for designated personnel in maintenance and operation of HVAC and control systems. Orientate training to the specific system being installed under the contract. Furnish audiovisual equipment and other training materials and supplies. A training day is defined as 8 hours of classroom or lab instruction, including two 15-minute breaks and excluding lunch time, Monday through Friday, during the daytime shift in effect at the training facility. For guidance, assume that the attendees have a high school education and are familiar with HVAC systems. Submit planned training schedule, agenda, and class materials to the Government at least 45 days prior to training.

3.4.1 Training Course Documentation

Training shall be based on the operation and maintenance manuals and control system training manual. Deliver manuals for each trainee with two additional sets for archiving at the project site. Include an agenda, defined objectives, and a detailed description of subject matter for each lesson.

3.4.2 Operator Training I

The first class shall be taught for a period of 5 consecutive training days at least 1 month prior to the scheduled performance verification test. The first course shall be taught in a Government-provided facility on base. Training shall be classroom instruction, but have hands-on operation of similar digital controllers. Maximum of 5 personnel shall attend the course. Upon completion of course, each student, using appropriate documentation, shall be able to perform elementary operations, with guidance, and describe general hardware and functionality of the system. Course shall include but not be limited to description of hardware and operation of the system.

3.4.3 Operator Training II

The second course shall be taught in the field, using the operating equipment at project sites for a total of 16 hours of instruction per student, in blocks of 4 hours. Maximum of 5 personnel shall attend the course. Include hands-on training under constant monitoring of instructor. Course content shall duplicate the Operator Training I course as applied to the installed system. Instructor shall determine the level of the password to be issued to each student before each session. Upon completion of the course, students shall be proficient in system operation. Prepare a written report describing the skill level of each student at the end of the course.

3.4.4 Operator Training III

The third course shall be taught in the field, at the project site, for a period of 3 training days no later than 6 months after completion of endurance test. Maximum of 5 personnel shall attend the course. Course shall be structured to address specific topics that the students need to discuss and to answer questions concerning operation of the system. Upon completion of the course, students shall be proficient in system operation and shall have no unanswered questions regarding operation of the installed system.

3.4.5 System Maintenance Training

Course shall be taught at the project site within one month after completion of endurance test for a period of 2 training days. Maximum of 5 personnel shall attend the course. Course shall include but not be limited to the following:

- a. Physical layout for each piece of hardware
- b. Troubleshooting and diagnostics procedures
- c. Repair instructions
- d. Preventive maintenance procedures and schedule
- e. Calibration procedures

3.5 QUALIFIED SERVICE ORGANIZATION LIST

The qualified service organization list shall include names and telephone numbers of organizations qualified to service HVAC control systems.

3.6 COMMISSIONING

Commissioning of control systems is specified in the pre-field TAB engineering report described in Section 23 05 93 TESTING, ADJUSTING AND BALANCING.

-- End of Section --

SECTION 23 09 93

SEQUENCES OF OPERATION FOR HVAC CONTROL 11/15

PART 1 GENERAL

1.1 DEFINITIONS

For definitions related to this Section, see Section 23 09 00
INTRUMENTATION AND CONTROL FOR HVAC.

1.2 SUBMITTALS

Submittals related to this Section are specified in Section 23 09 00
INTRUMENTATION AND CONTROL FOR HVAC.

PART 2 PRODUCTS

Products related to this Section are specified in Section 23 09 00
INTRUMENTATION AND CONTROL FOR HVAC and related Sections 23 09 13
INSTRUMENTATION AND CONTROL DEVICES FOR HVAC.

23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING
CONTROL SYSTEMS.

PART 3 EXECUTION

3.1 SEQUENCES OF OPERATION FOR OCCUPANCY SCHEDULING

3.1.1 System Mode

Operate air handling units (AHUs) in Occupied, Warm-Up-Cool-Down, or Unoccupied modes as specified. VAV boxes, Fan Coils, and operate other terminal equipment in Occupied or Unoccupied modes as specified. Chillers, boilers, and other sources of heating/cooling for hydronic loads do not require scheduling; these systems receive requests for heating/cooling from their loads.

3.1.2 System Scheduler Requirements

The System Scheduler functionality must reside in either a piece of DDC Hardware dedicated to this functionality or in the DDC Hardware controlling the system AHU. A single piece of DDC Hardware dedicated to scheduling (performing no other control functionality) may contain multiple System Schedulers. Provide a unique System Scheduler for: each AHU including it's associated Terminal Units, and each stand-alone Terminal Unit (those not dependent upon AHU service). Each System Scheduler must provide the following functionality:

3.1.2.1 Scheduled Occupancy Input

Accept network variable of type SNVT_occupancy. Support the following possible values: OC_STANDBY, OC_OCCUPIED and OC_UNOCCUPIED.

3.1.2.2 Occupancy Override Input

Accept network variable of type SNVT_occupancy. Support the following

possible values: OC_STANDBY, OC_OCCUPIED, OC_UNOCCUPIED, and OC_NUL.

3.1.2.3 Space Occupancy Inputs

For systems with multiple occupancy sensors, accept multiple inputs of network variable type SNVT_Occupancy. Support the following possible values: OC_OCCUPIED, OC_UNOCCUPIED, and OC_NUL. For systems with a single occupancy sensor, accept a network variable input of type SNVT_Occupancy or a hardware binary input (BI) indicating the space occupancy status as Occupied or Unoccupied.

3.1.2.4 Air Handler Occupancy Output

For a System Scheduler for a system containing an air handler, output one or more SNVTs indicating the desired occupancy status as one of the following possible values: Warm-Up-Cool-Down (when required by the AHU Sequence of Operation), Occupied and Unoccupied.

3.1.2.5 Terminal Unit Occupancy Output

For a System Scheduler for a stand-alone terminal unit, or a group of terminal units served by a single air handler, output one or more SNVTs indicating the desired occupancy status as one of the following possible values: Occupied and Unoccupied.

3.1.2.6 Default Schedule

Incorporate a 24-hour 7-day default schedule as shown on the drawings which may be activated and deactivated by the System Scheduler Logic.

3.1.2.7 Communication Determination

Determine the time elapsed between receipts of the scheduled occupancy input SNVT, and use this elapsed time to activate and deactivate the Default Schedule as specified. (This provides the capability for the system scheduler to use its Default Schedule if it loses communication with the UMCS).

3.1.3 System Scheduler Output Determination

For controlling an Air Handler, interpret a SNVT input of OC_STANDBY as Warm-Up-Cool-Down if the sequence of operation supports that mode, otherwise interpret OC_STANDBY as Occupied. For Terminal Units, interpret OC_STANDBY as Occupied.

3.1.3.1 Air Handler Occupancy Output

If more than 95 minutes have passed since the last receipt of the Scheduled Occupancy input, determine the Air Handler Occupancy Output by the default schedule and the Space Occupancy Inputs. Otherwise, determine the output as follows:

- a. If the Override Occupancy Input is not OC_NUL, determine the Air Handler Occupancy Output from the Override Occupancy Input.
- b. Otherwise, if at least the required number (as shown on the Occupancy Schedule Drawing) of Space Occupancy Inputs are OC_OCCUPIED or the hardware BI is Occupied the Air Handler Occupancy Output must be OC_OCCUPIED.

- c. Otherwise, determine the Air Handler Occupancy Output from the Scheduled Occupancy Input SNVT.

3.1.3.2 Terminal Unit Occupancy Output

If more than 95 minutes have passed since the last receipt of the Scheduled Occupancy input, determine the Terminal Unit Occupancy Output by the default schedule. Otherwise, determine the output as follows:

- a. If the Override Occupancy Input is not OC_NUL, determine the Terminal Unit Occupancy Output from the Override Occupancy Input SNVT:
- b. Otherwise, determine the Terminal Unit Occupancy Output from the Scheduled Occupancy SNVT.

3.1.4 Air Handler System Scheduling

- a. Bind the AHU Occupancy Output SNVT from the System Scheduler to the DDC Hardware that executes the Occupancy Mode Determination part of the Air Handler Sequence of Operation
- b. For Air Handlers using occupancy sensors, bind the output SNVT (of type SNVT_Occupancy) of each occupancy sensor to a Space Occupancy Input of the System Scheduler.
- c. Bind the Terminal Unit Occupancy Output SNVT from the System Scheduler to each AHU-Dependent Terminal Unit.
- d. AHU-Dependent Terminal Units with occupancy sensors must have the Effective Occupancy SNVT (of type SNVT_Occupancy) of each Terminal Unit bound to a Space Occupancy Input of the System Scheduler.

3.1.5 Stand-Alone Terminal Unit Scheduling

Bind the Terminal Unit Occupancy Output from the System Scheduler to the DDC Hardware that executes the Occupancy Mode Determination part of the Terminal Unit Sequence of Operation.

3.2 SEQUENCES OF OPERATION FOR AIR HANDLING UNITS

3.2.1 All-Air Small Package Unitary System

Install DDC hardware to perform this Sequence of Operation and to provide SNVT inputs and outputs as specified and shown on the Points Schedule. Unless otherwise specified, all modulating control must be proportional-integral (PI) control.

3.2.1.1 Fan ON-AUTO Switch

3.2.1.1.1 ON

With the thermostat fan ON-AUTO switch in the ON position, the DDC Hardware must start and continuously run the fan.

3.2.1.1.2 AUTO

With the thermostat fan ON-AUTO switch in the AUTO position, the DDC Hardware operates the fan according to HEAT-OFF-COOL switch.

3.2.1.2 HEAT-OFF-COOL Switch

3.2.1.2.1 HEAT-COOL

With the thermostat switch in the HEAT or COOL positions, use the DDC Hardware to operate the package unit according to the Occupancy Mode.

3.2.1.2.2 OFF

With the thermostat switch in the OFF position, de-energize the heating unit and cooling unit with the DDC Hardware.

3.2.1.3 Occupancy Modes

3.2.1.3.1 Occupied

The unit DDC Hardware must be in the Occupied Mode when the local space occupancy input(s) indicate that the space is occupied or when the input from the System Scheduler is occupied.

3.2.1.3.2 Unoccupied

The unit DDC Hardware must be in the Unoccupied Mode when the local space occupancy input(s) indicate that the space is unoccupied and when the input from the System Scheduler is unoccupied.

3.2.1.4 Safeties

Run the unit subject to the unit manufacturer's safeties.

3.2.1.5 Zone Temperature Control

- a. In the Occupied Mode the zone temperature setpoint (ZN-T-SP) must be at the configured setpoint or at the occupant-adjustable setpoint via the wall-mounted thermostat, as indicated.
- b. In the Unoccupied Mode the zone temperature setpoint (ZN-T-SP-UNOCC) must be at the configured setpoint (ZN-T-SP-UNOCC) as indicated.
- c. Cycle the fan, cooling unit, heating unit with the DDC Hardware, in accordance with the HEAT-COOL switch setting, to maintain zone temperature (ZN-T) at setpoint (ZN-T-SP).

3.2.2 Variable Air Volume System without Return Fan

Install DDC hardware to perform this Sequence of Operation and to provide SNVT inputs and outputs as specified and shown on the Points Schedule. Unless otherwise specified, all modulating control is proportional-integral (PI) control.

3.2.2.1 HAND-OFF-AUTO Switches

Provide supply fan variable frequency drive (VFD) unit to accept a Fire Alarm Panel (FAP) signal that takes precedence over all other VFD inputs and switches and causes the VFD to run at 100 percent speed. Provide VFD that accepts an occupant accessible emergency shutoff switch as shown. Provide supply fan variable frequency drive (VFD) unit with an integral H-O-A switch:

3.2.2.1.1 HAND

With the H-O-A switch in HAND position, start the supply fan and run continuously, subject to Safeties. Ensure fan speed is under manual-operator control.

3.2.2.1.2 OFF

With the H-O-A switch in OFF position, stop the supply fan.

3.2.2.1.3 AUTO

With the H-O-A switch in AUTO position, run the supply fan subject to the Supply Fan Start/Stop Signal (SF-SS) and Safeties. Ensure fan speed is under control of the DDC Hardware.

3.2.2.2 Occupancy Modes

Obtain Occupancy Mode input from the System Scheduler as specified and shown. Operate the system in one of the following modes: Occupied, Unoccupied, or Warm Up/Cool Down.

3.2.2.3 Proofs and Safeties

The supply fan and all DDC Hardware control loops are subject to Proofs and Safeties. Direct-hardwire interlock safeties to the VFD as shown. Monitor all proofs and safeties and disable all control loops and command the AHU fan off until reset due to failure of any proof or activation of any safety.

3.2.2.3.1 Proofs

- a. Supply fan status (SF-S)

3.2.2.3.2 Safeties

- a. Preheat coil discharge air temperature low limit (freezestat) (PH-DA-T-LL) for systems with a preheat coil. Cooling coil discharge air temperature low limit (freezestat) (CLG-DA-T-LL) for all other systems
- b. Supply air duct pressure high limit (SA-P-HL)
- c. Supply air smoke (SA-SMK)
- d. Return air smoke (RA-SMK)

3.2.2.3.3 DDC Hardware Reset

Reset all proofs and safeties via a local binary push-button (RST-BUT) input to the DDC Hardware, via a remote command to the DDC Hardware via SNVT or both (where the Contractor provides both reset functions and the operator can use either one to perform the reset), as shown on the Points Schedule drawing.

3.2.2.4 System Enable and Loop Enable

3.2.2.4.1 Occupied Mode

Enable the supply fan (SYS-ENA) and command to run (SF-SS). Enable all control loops.

3.2.2.4.2 Unoccupied Mode

While the building temperature (BLDG-T) is above the low limit setpoint (BLDG-T-LL) disable all control loops and do not run the supply fan. When BLDG-T drops below BLDG-T-LL (with a 5 degrees F deadband), enable the supply fan (SYS-ENA) and command to run (SF-SS), enable the Supply Duct Static Pressure Control loops. Disable the Minimum Outside Air Flow Control, Mixed Air Temperature Control, and Cooling Coil Control loops.

3.2.2.4.3 Warm Up/Cool Down

Enable the supply fan (SYS-ENA) and command to run (SF-SS). Disable the Minimum Outside Air Flow Control loop and enable all other control loops.

3.2.2.5 Fan Capacity Control

3.2.2.5.1 Supply Duct Static Pressure Control

When this loop is enabled, modulate the supply fan variable frequency drive unit to maintain the duct static pressure (SA-P) at setpoint (SA-P-SP) as shown, as measured by the duct static pressure tap and sensor as shown. When this loop is disabled, ensure the DDC Hardware capacity modulation output to the VFD is zero percent.

3.2.2.6 Minimum Outside Air Flow Control

When this loop is enabled, modulate the minimum outside air damper to maintain the minimum OA volumetric flow (MINOA-F) at setpoint (MINOA-F-SP) as shown. When this loop is disabled, close the minimum outside air damper.

3.2.2.7 Mixed Air Temperature Control With Economizer

3.2.2.7.1 Enabled Loop

When this loop is enabled, and the Economizer is ON as determined by the Economizer Enable Logic, modulate the economizer outside air, relief, and return air dampers to maintain the mixed air temperature (MA-T) at setpoint (MA-T-SP) as shown.

3.2.2.7.2 Disabled Loop

When this loop is disabled, or the Economizer is OFF as determined by the Economizer Enable Logic, close the economizer outside air and relief air dampers, and open the return air damper.

3.2.2.7.3 Economizer Enable Logic

Ensure the economizer is ON when the outside air dry bulb temperature is between the high limit (ECO-HL-SP) and low limit (ECO-LL-SP) setpoints as shown. Otherwise the Economizer is OFF. Ensure ECO-HL-SP and ECO-LL-SP each have a 2 degrees F deadband.

3.2.2.8 Cooling Coil Control

When this loop is enabled, modulate the cooling coil valve to maintain the supply air temperature (SA-T) setpoint (SA-T-SP) as shown. When this loop is disabled, close the cooling coil valve.

3.2.2.9 Preheat Coil Control

When this loop is enabled, modulate the preheat coil valve to maintain the preheat coil discharge air temperature (PH-DA-T) at setpoint (PH-DA-T-SP) as shown. When this loop is disabled, close the preheat coil valve.

3.3 SEQUENCES OF OPERATION FOR TERMINAL UNITS

3.3.1 Zone Temperature Control - Cooling-Only VAV Box

Install DDC hardware to perform this Sequence of Operation and to provide SNVT inputs and outputs as specified and shown on the Points Schedule. Unless otherwise specified, all modulating control is proportional-integral (PI) control.

3.3.1.1 Occupancy Modes

3.3.1.1.1 Occupied

Ensure the VAV box DDC Hardware is in the Occupied Mode when the local space occupancy input(s) (ZN-OCC) indicate that the space is occupied or when the input from the System Scheduler (SYS-OCC) is occupied.

3.3.1.1.2 Unoccupied

The VAV box DDC Hardware must be in the Unoccupied Mode when the local space occupancy input(s) (ZN-OCC) indicate that the space is unoccupied and the input from the System Scheduler (SYS-OCC) is unoccupied.

Safeties

This system has no safeties.

3.3.1.2 Zone Temperature Control

3.3.1.2.1 Occupied Mode

In the Occupied Mode the zone temperature setpoint (ZN-T-SP) must be at the configured setpoint or at the occupant-adjustable setpoint via the wall-mounted thermostat, as shown. The DDC Hardware must modulate the VAV box damper to maintain VAV box supply air flow (VAV-SA-F) at setpoint as measured by a multi-point flow sensing element at the inlet to the VAV box. Sequence as indicated: Upon a rise in zone temperature (ZN-T) above zone setpoint (ZN-T-SP), subject to the zone temperature setpoint deadband as indicated, adjust the airflow setpoint between minimum and maximum flow based on the difference between zone temperature and zone temperature setpoint as indicated.

3.3.1.2.2 Unoccupied Mode

In the Unoccupied Mode, ensure the VAV box damper is at its minimum position.

3.3.2 Zone Temperature Control - VAV Box with Reheat

Install DDC hardware to perform this Sequence of Operation and to provide SNVT inputs and outputs as specified and shown on the Points Schedule. Unless otherwise specified, all modulating control is proportional-integral (PI) control.

3.3.2.1 Occupancy Modes

3.3.2.1.1 Occupied

Ensure the VAV box DDC Hardware is in the Occupied Mode when the local space occupancy input(s) (ZN-OCC) indicate that the space is occupied or when the input from the System Scheduler (SYS-OCC) is occupied.

3.3.2.1.2 Unoccupied

Ensure the VAV box DDC Hardware is in the Unoccupied Mode when the local space occupancy input(s) (ZN-OCC) indicate that the space is unoccupied and the input from the System Scheduler (SYS-OCC) is unoccupied.

3.3.2.2 Zone Temperature Control

- a. In the Occupied Mode, ensure the zone temperature setpoint (ZN-T-SP) is at the configured setpoint or at the occupant-adjustable setpoint via the wall-mounted thermostat, as shown.
- b. In the Unoccupied Mode, ensure the zone temperature setpoint (ZN-T-SP) is at the configured setpoint as shown.
- c. Modulate the VAV box damper to maintain VAV box supply air flow (VAV-SA-F) at setpoint as measured by a multi-point flow sensing element at the inlet to the VAV box. Perform sequencing as shown: Upon a rise in zone temperature above zone temperature setpoint (ZN-T-SP), subject to the zone temperature setpoint deadband as shown, adjust the airflow setpoint between minimum and maximum flow based on the difference between zone temperature and zone temperature setpoint as shown. Upon a fall in zone temperature below zone temperature setpoint, subject to the deadband as shown, maintain the airflow at a fixed air flow setpoint (with a setting independent of the cooling minimum air flow), and modulate the heating valve towards open or cycle the staged electric resistance heating coil(s) on in sequence.

3.3.3 Unit Heater and Cabinet Unit Heater

Install DDC hardware to perform this Sequence of Operation and to provide SNVT inputs and outputs as specified and shown on the Points Schedule. Unless otherwise specified, all modulating control is proportional-integral (PI) control.

3.3.3.1 Off-Auto Switch

3.3.3.1.1 OFF

With the thermostat OFF-AUTO switch in the OFF position, stop the fan and close the heating control valve.

3.3.3.1.2 AUTO

With the thermostat OFF-AUTO switch in the AUTO position, control the unit in accordance with its Occupancy Mode.

3.3.3.2 Occupancy Modes

3.3.3.2.1 Occupied

Ensure the unit heater DDC Hardware is in the Occupied Mode when the local space occupancy input(s) indicate that the space is occupied or when the input from the System Scheduler is occupied.

3.3.3.2.2 Unoccupied

Ensure the unit heater DDC Hardware is in the Unoccupied Mode when the local space occupancy input(s) indicate that the space is unoccupied and when the input from the System Scheduler is unoccupied.

3.3.3.3 Safeties

Run the unit subject to the unit manufacturer's safeties.

3.3.3.4 Space Temperature Control

3.3.3.4.1 Occupied Mode

In the Occupied Mode, modulate the heating control valve and cycle the multi-speed fan to maintain space temperature at the configured setpoint or at the occupant-adjustable setpoint via the wall-mounted thermostat, as shown.

3.3.3.4.2 Unoccupied Mode

In the Unoccupied Mode, modulate the heating control valve and cycle the multi-speed fan to maintain space temperature at the configured setpoint as shown.

3.4 SEQUENCES OF OPERATION FOR HYDRONIC SYSTEMS

3.4.1 Hydronic Heating Hot Water From Single-Building Boiler

Install DDC hardware to perform this Sequence of Operation and to provide SNVT inputs and outputs as specified and shown on the Points Schedule. Unless otherwise specified, all modulating control is proportional-integral (PI) control.

3.4.1.1 System Enable and Loop Enable

- a. Monitor the enabled status of all systems served by this system. If one or more systems served by this system are enabled, enable this system (SYS-ENA). If no systems served by this system are enabled, disable this system.
- b. When this system is enabled (SYS-ENA) and the hot water pump is proofed on, enable the boiler control and hot water temperature control loops.

3.4.1.2 HAND-OFF-AUTO Switch

Provide hot water pump motor starter with an H-O-A switch:

3.4.1.2.1 HAND

With the H-O-A switch in HAND position, start the pump and run continuously.

3.4.1.2.2 OFF

With the H-O-A switch in OFF position, stop the pump.

3.4.1.2.3 AUTO

With the H-O-A switch in AUTO position, run the pump subject to the Hot Water Pump Start/Stop (HW-PMP-SS) command.

3.4.1.3 Proofs and Safeties

DDC Hardware must monitor all proofs and safeties.

3.4.1.3.1 Proofs

Hot water pump

3.4.1.3.2 Safeties

None

3.4.1.3.3 DDC Hardware Reset

Reset all proofs and safeties via a local binary push-button (RST-BUT) input to the DDC Hardware, via a remote command to the DDC Hardware via SNVT or both (where the Contractor provides both reset functions and the operator can use either one to perform the reset), as shown on the Points Schedule drawing.

3.4.1.4 Boiler Control

When this loop is enabled, turn the boiler on. When this loop is disabled, the boiler is turned off.

3.4.1.5 Hot Water Temperature Control

When this loop is enabled modulate **boiler** to maintain hot water supply temperature (HWS-T) at setpoint (HWS-T-SP). The Hot Water Supply Temperature Setpoint (HWS-T-SP) must be determined from a linear reset schedule as shown. When this loop is disabled, the valve is in its normal (failsafe) position.

3.4.2 Hydronic Secondary with Variable Speed Pump

Install DDC hardware to perform this Sequence of Operation and to provide SNVT inputs and outputs as specified and shown on the Points Schedule. Unless otherwise specified, all modulating control is proportional-integral (PI) control.

3.4.2.1 System Enable and Loop Enable:

- a. Monitor the enabled status of all systems served by this system. If one or more systems served by this system are enabled, enable this system (SYS-ENA). If all systems served by this system are not enabled, do not enable this system.
- b. When this system is enabled (SYS-ENA) the Pressure Control loop must be enabled.

3.4.2.2 HAND-OFF-AUTO Switch

Provide hot water pump variable frequency drive (VFD) unit with an integral H-O-A switch:

3.4.2.2.1 HAND

With the H-O-A switch in HAND position, the pump starts and runs continuously. Ensure pump speed is under manual-operator control.

3.4.2.2.2 OFF

With the H-O-A switch in OFF position, the pump stops.

3.4.2.2.3 AUTO

With the H-O-A switch in AUTO position, run the pump subject to the Hot Water Pump Start/Stop (HW-PMP-SS) command and ensure pump speed is under control of the DDC system.

3.4.2.3 Proofs and Safeties

DDC Hardware must monitor all proofs and safeties.

3.4.2.3.1 Proofs

None

3.4.2.3.2 Safeties

None

3.4.2.3.3 DDC Hardware Reset

Reset all proofs and safeties via a local binary push-button (RST-BUT) input to the DDC Hardware, via a remote command to the DDC Hardware via SNVT or both (where the Contractor provides both reset functions and the operator can use either one to perform the reset), as shown on the Points Schedule drawing.

3.4.2.4 Pressure Control

When this loop is enabled modulate the pump variable frequency drive unit to maintain the pipe system pressure at setpoint as shown, as measured by the differential pressure tap and sensor as shown. When this loop is disabled, ensure the DDC Hardware capacity modulation output to the VFD is zero percent.

-- End of Section --

SECTION 23 11 20

FACILITY GAS PIPING
05/20

PART 1 GENERAL

1.1 SUMMARY

This specification section applies to gas piping installed within buildings incidental underground piping under building, above ground steel piping and corrugated stainless steel tubing (CSST) both outside (up to 5 feet beyond exterior walls) and within buildings in compliance with NFPA 54 /AGA Z223.1, "National Fuel Gas Code" NFPA 58, "Fuel Gas Piping".

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN GAS ASSOCIATION (AGA)

AGA Z223.1 (2012) National Fuel Gas Code

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z21.18/CSA 6.3 (2007; R 2017) Gas Appliance Pressure Regulators

ANSI Z21.24/CSA 6.10 (2022) Connectors for Gas Appliances

ANSI Z21.41/CSA 6.9 (2014; R 2019) Quick-Disconnect Devices for Use with Gas Fuel Appliances

ANSI Z21.69/CSA 6.16 (2015; R 2020) Connectors for Movable Gas Appliances

ANSI Z21.93/CSA 6.30 (2017) Excess Flow Valves for Natural Gas and Propane Gas with Pressures up to 5 psig

AMERICAN PETROLEUM INSTITUTE (API)

API RP 2009 (2002; R 2007; 7th Ed) Safe Welding, Cutting, and Hot Work Practices in Refineries, Gasoline Plants, and Petrochemical Plants

API Std 598 (2009) Valve Inspecting and Testing

API Std 607 (2016) Fire Test for Quarter-turn Valves and Valves Equipped with Non-metallic Seats

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 25-16 (2016) Earthquake-Activated Automatic Gas Shutoff Devices

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.1	(2003; R 2018) Unified Inch Screw Threads (UN and UNR Thread Form)
ASME B1.20.1	(2013; R 2018) Pipe Threads, General Purpose (Inch)
ASME B16.21	(2021) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.33	(2012; R 2017) Manually Operated Metallic Gas Valves for Use in Gas Piping Systems Up to 125 psi, (Sizes NPS 1/2 - NPS 2)
ASME B18.2.1	(2012; Errata 2013) Square and Hex Bolts and Screws (Inch Series)
ASME B18.2.2	(2022) Nuts for General Applications: Machine Screw Nuts, and Hex, Square, Hex Flange, and Coupling Nuts (Inch Series)
ASME B31.9	(2020) Building Services Piping
ASME BPVC SEC IX	(2017; Errata 2018) BPVC Section IX-Welding, Brazing and Fusing Qualifications

AMERICAN WELDING SOCIETY (AWS)

AWS A5.8/A5.8M	(2019) Specification for Filler Metals for Brazing and Braze Welding
AWS D10.12M/D10.12	(2000) Guideline for Welding Mild Steel Pipe
AWS WHB-2.9	(2004) Welding Handbook; Volume 2, Welding Processes, Part 1

ASTM INTERNATIONAL (ASTM)

ASTM A193/A193M	(2022a) Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service and Other Special Purpose Applications
ASTM A194/A194M	(2022) Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both
ASTM F2015	(2000; R 2013) Standard Specification for Lap Joint Flange Pipe End Applications

CSA GROUP (CSA)

ANSI LC 1/CSA 6.26	(2019) Fuel Gas Piping Systems Using Corrugated Stainless Steel Tubing (CSST)

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS
INDUSTRY (MSS)

MSS SP-25 (2018) Standard Marking System for Valves,
Fittings, Flanges and Unions

MSS SP-58 (2018) Pipe Hangers and Supports -
Materials, Design and Manufacture,
Selection, Application, and Installation

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 54 (2021) National Fuel Gas Code

NFPA 58 (2020; TIA 20-1; TIA 20-2; TIA 20-3)
Liquefied Petroleum Gas Code

NFPA 70 (2023) National Electrical Code

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION
(SMACNA)

SMACNA 1981 (2008) Seismic Restraint Manual Guidelines
for Mechanical Systems, 3rd Edition

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-STD-101 (2014; Rev C) Color Code for Pipelines and
for Compressed Gas Cylinders

UNDERWRITERS LABORATORIES (UL)

UL FLAMMABLE & COMBUSTIBLE (2012) Flammable and Combustible Liquids
and Gases Equipment Directory

1.3 SYSTEM DESCRIPTION

The gas piping system includes natural gas piping and appurtenances from point of connection with supply system, as indicated, to gas operated equipment within the facility. Submit operation and maintenance data in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA, in three separate packages.

1.3.1 Gas Facility System and Equipment Operation

Include shop drawings showing piping layout, locations of system valves, gas line markers; step-by-step procedures for system start up, operation and shutdown (index system components and equipment to the system drawings); isolation procedures including valve operation to shutdown or isolate each section of the system (index valves to the system maps and provide separate procedures for normal operation and emergency shutdown if required to be different). Submit Data package No. 4.

1.3.2 Gas Facility System Maintenance

Include maintenance procedures and frequency for system and equipment; identification of pipe materials and manufacturer by locations, pipe repair procedures, and jointing procedures at transitions to other piping material or material from a different manufacturer. Submit Data Package

No.4.

1.3.3 Gas Facility Equipment Maintenance

Include identification of valves, shut-offs, disconnects, and other equipment by materials, manufacturer, vendor identification and location; maintenance procedures and recommended tool kits for valves and equipment; recommended repair methods (i.e., field repair, factory repair, or replacement) for each valve and piece of equipment; and preventive maintenance procedures, possible failure modes and troubleshooting guide. Submit Data Package No. 3.

1.4 SUBMITTALS

Government approval is required for submittals. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Gas Piping System;

Coordination Drawings

SD-03 Product Data

Gas Equipment Connectors;

Gas Piping System;

Pipe Coating Materials;

Pressure Regulators;

Risers; G

Valves; G

Warning and Identification Tape;

SD-06 Test Reports

Testing;

Pressure Tests;

Test with Gas;

SD-07 Certificates

Welders Procedures and Qualifications;

Assigned Number, Letter, or Symbol;

Designer Qualifications

SD-08 Manufacturer's Instructions

Pipe Coating Materials;

SD-10 Operation and Maintenance Data

Gas Facility System and Equipment Operation;

Gas Facility System Maintenance;

Gas Facility Equipment Maintenance;

1.5 QUALITY ASSURANCE

Submit manufacturer's descriptive data and installation instructions for approval for compression-type mechanical joints used in joining dissimilar materials and for insulating joints. Mark all valves, flanges and fittings in accordance with **MSS SP-25**.

1.5.1 Designer Qualifications

Design natural gas system under direct supervision of a professional engineer experienced in designing this work and licensed in the State of Alabama.

1.5.2 Welding Qualifications

- a. Weld piping in accordance with qualified procedures using performance qualified welders and welding operators in accordance with **API RP 2009**, **ASME BPVC SEC IX**, and **ASME B31.9**. Welding procedures qualified by others, and welders and welding operators qualified by another employer may be accepted as permitted by **ASME B31.9**. Notify the Contracting Officer at least 24 hours in advance of tests, and perform at the work site if practicable.
- b. Submit a certified copy of **welders procedures and qualifications** metal and PE in conformance with **ASME B31.9** for each welder and welding operator. Submit the **assigned number, letter, or symbol** that will be used in identifying the work of each welder to the Contracting Officer. Weld all structural members in conformance with **AWS D1.1/D1.1M**, **AWS A5.8/A5.8M**, and **AWS WHB-2.9**.

1.5.3 Electrical Components, Devices, and Accessories

Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.5.4 Shop Drawings

Submit drawings at **1/4 inch scale** for complete **Gas Piping System**, within 30 days of contract award, showing location, size and all branches of pipeline; location of all required shutoff valves; and instructions necessary for the installation of **gas equipment connectors** and supports. Provide details for fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to building structure

Submit Coordination Drawings providing plans and details, drawn to 1/4 inch scale, on which natural-gas piping is shown and coordinated with other installations, using input from installers of the items involved.

1.6 DELIVERY, STORAGE, AND HANDLING

Handling Flammable Liquids: Remove and dispose of liquids from existing natural-gas piping according to requirements of authorities having jurisdiction.

Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

Store and handle pipes and tubes having factory-applied protective coatings to avoid damaging coating, and protect from direct sunlight.

Protect stored PE pipes and valves from direct sunlight.

Discard any tubing segment or fitting that has been damaged.

1.7 PROJECT CONDITIONS

Perform site survey, and verify existing utility locations.

Interruption of Existing Natural-Gas Service: Do not interrupt natural-gas service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide purging and startup of natural-gas supply according to requirements indicated:

- a. Notify Construction Manager and Owner no fewer than seven days in advance of proposed interruption of natural-gas service.
- b. Do not proceed with interruption of natural-gas service without Construction Manager's and Owner's written permission.

1.8 COORDINATION

Coordinate sizes and locations of concrete bases with actual equipment provided.

Coordinate requirements for access panels and doors for valves installed concealed behind finished surfaces. Comply with requirements in Section 08 31 00 "Access Doors and Frames."

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

Provide materials and equipment which are the standard products of a manufacturer regularly engaged in the manufacture of the products and that essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Asbestos or products containing asbestos are not allowed. Submit catalog data and installation instructions for pipe, valves, all related system components, pipe coating materials and application procedures. Conform to NFPA 54 and with requirements specified herein. Provide supply piping to appliances or equipment at least as large as the inlets thereof.

2.2 GAS PIPING SYSTEM AND FITTINGS

2.2.1 Steel Pipe, Joints, and Fittings

- A. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
 - 1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
 - 2. Wrought-Steel Welding Fittings: ASTM A 234/A 234M for butt welding and socket welding.
 - 3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
 - 4. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
 - a. Material Group: 1.1.
 - b. End Connections: Threaded or butt welding to match pipe.
 - c. Lapped Face: Not permitted underground.
 - d. Gasket Materials: ASME B16.20, metallic, flat, asbestos free, aluminum o-rings, and spiral-wound metal gaskets.
 - e. Bolts and Nuts: ASME B18.2.1, carbon steel aboveground and stainless steel underground.
 - 5. Protective Coating for Underground Piping: Factory-applied, three-layer coating of epoxy, adhesive, and PE.
 - a. Joint Cover Kits: Epoxy paint, adhesive, and heat-shrink PE sleeves.

2.2.2 Corrugated Stainless Steel Tubing, Fittings and Accessories

Provide corrugated stainless steel tubing conforming to ANSI LC 1/CSA 6.26 (austenitic stainless steel of series 300) with tubing joints made with special mechanical fittings as supplied by the tubing manufacturer.

2.2.2.1 Tubing

Austenitic stainless alloy of series 300 with polyethylene jacket/coating in accordance with ASTM A240/A240M and ANSI LC 1/CSA 6.26 for sizes 3/8-inch through 2-inch. Provide PE coating with flame retardant, Flame-Spread Index of 25 or less, Smoke-Developed Index of 50 or less per ASTM E84

2.2.2.2 Mechanical Fittings

Copper alloy with one end matched to the corrugated tubing and one end with NPT threads in accordance with ASME B1.20.1

2.2.2.3 Striker Plates

Hardened steel designed to protect tubing from mechanical damage in accordance with ANSI LC 1/CSA 6.26

2.2.2.4 Manifolds

Malleable iron, steel or copper alloy with threaded connections/ports in accordance with ASME B1.20.1

2.2.2.5 Operating-Pressure Rating

2 psig.

2.2.3 Sealants for Steel Pipe Threaded Joints

Provide joint sealing compound as listed in UL FLAMMABLE & COMBUSTIBLE, Class 20 or less. For taping, use tetrafluoroethylene tape conforming to UL FLAMMABLE & COMBUSTIBLE.

2.2.4 Warning and Identification

Provide pipe flow markings, warning and identification tape, and metal tags as required.

2.2.5 Flange Gaskets

Provide gaskets of nonasbestos compressed material in accordance with ASME B16.21, 1/16 inch thickness, full face or self-centering flat ring type, containing aramid fibers bonded with styrene butadiene rubber (SBR) or nitrile butadiene rubber (NBR) suitable for a maximum 600 degree F service, to be used for hydrocarbon service.

2.2.6 Pipe Threads

Provide pipe threads conforming to ASME B1.20.1.

2.2.7 Filler Metals

Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

Brazing Filler Metals: Alloy with melting point greater than 1000 deg F complying with AWS A5.8/A5.8M. Brazing alloys containing more than 0.05 percent phosphorus are prohibited.

2.2.8 Escutcheons

Provide chromium-plated steel or chromium-plated brass escutcheons, either one piece or split pattern, held in place by internal spring tension or set screw.

2.2.9 DIELECTRIC FITTINGS

General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

2.2.9.1 Dielectric Unions:

ASSE 1079; Rating - 125 psig minimum at 180 deg F; Solder-joint copper alloy and threaded ferrous end connections.

2.2.9.2 Dielectric Flanges:

ASSE 1079; Factory-fabricated, bolted, companion-flange assembly; Pressure Rating - 125 psig minimum at 180 deg F.

- a. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

2.2.10 Insulating Pipe Joints

2.2.10.1 Insulating Joint Material

Provide insulating joint material between flanged or threaded metallic pipe systems where shown to control galvanic or electrical action.

2.2.10.2 Threaded Pipe Joints

Provide threaded pipe joints of steel body nut type dielectric unions with insulating gaskets.

2.2.10.3 Flanged Pipe Joints

Provide joints for flanged pipe consisting of full face sandwich-type flange insulating gasket of the dielectric type, insulating sleeves for flange bolts, and insulating washers for flange nuts. Provide lap joint flange pipe ends conforming to [ASTM F2015](#).

2.2.11 Flexible Connectors

- a. Provide flexible connectors for connecting gas utilization equipment to building gas piping conforming to [ANSI Z21.24/CSA 6.10](#) or [ANSI Z21.41/CSA 6.9](#) for quick disconnect devices, and flexible connectors for movable food service equipment conforming to [ANSI Z21.69/CSA 6.16](#).
 1. Indoor, Fixed-Appliance Flexible Connectors: Comply with [ANSI Z21.24/CSA 6.10](#).
 2. Indoor, Movable-Appliance Flexible Connectors: Comply with [ANSI Z21.69/CSA 6.16](#).
 3. Outdoor, Appliance Flexible Connectors: Comply with [ANSI Z21.75](#).
 4. Corrugated stainless-steel tubing with polymer coating.
 5. Operating-Pressure Rating: 0.5 psig.
 6. End Fittings: Zinc-coated steel.
 7. Threaded Ends: Comply with [ASME B1.20.1](#).
 8. Maximum Length: 72 inches.
- b. Do not install the flexible connector through the appliance cabinet face. Provide rigid metallic pipe and fittings to extend the final connection beyond the cabinet, except when appliance is provided with an external connection point.

2.3 VALVES

Provide lockable shutoff or service isolation valves as indicated in the drawings conforming to the following:

2.3.1 Metallic Valves, NPS 2 and Smaller

- a. Comply with ASME B16.33.
- b. CWP Rating: 125 psig.
- c. Threaded Ends: Comply with ASME B1.20.1.
- d. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
- c. Tamperproof Feature: Locking feature for valves indicated in "Aboveground Manual Gas Shutoff Valve Schedule".
- d. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch and smaller.
- e. Service Mark: Valves 1-1/4 inches to NPS 2 shall have initials "WOG" permanently marked on valve body.

2.3.2 Metallic Valves, NPS 2-1/2 and Larger

- a. Comply with ASME B16.38.
- b. CWP Rating: 125 psig.
- c. Flanged Ends: Comply with ASME B16.5 for steel flanges.
- d. Tamperproof Feature: Locking feature for valves indicated in "Aboveground Manual Gas Shutoff Valve Schedule".
- e. Service Mark: Initials "WOG" shall be permanently marked on valve body.

2.3.3 Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim

- a. Comply with MSS SP-110.
- b. Body: Bronze, complying with ASTM B 584.
- c. Ball: Chrome-plated bronze.
- d. Stem: Bronze; blowout proof.
- e. Seats: Reinforced TFE; blowout proof.
- f. Packing: Threaded-body packnut design with adjustable-stem packing.
- g. Ends: Threaded, flared, or socket as indicated in "Aboveground Manual Gas Shutoff Valve Schedule".
- h. CWP Rating: 600 psig.
- i. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.

- j. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

2.4 RISERS

Provide manufacturer's standard riser, transition from plastic to steel pipe with 7 to 12 mil thick epoxy coating. Use swaged gas-tight construction with O-ring seals, metal insert, and protective sleeve. Provide riser supports.

2.5 PIPE HANGERS AND SUPPORTS

Provide pipe hangers and supports conforming to MSS SP-58.

2.6 LINE AND APPLIANCE REGULATORS AND SHUTOFF VALVES

Provide pressure regulators conforming to ANSI Z21.18/CSA 6.3 for appliances .

2.6.1 General Requirements:

Provide a manual gas shutoff valve for each gas appliance ahead of corrugated stainless steel tubing connector.

Single stage and suitable for natural gas; Steel jacket and corrosion-resistant components; Elevation compensator; End Connections, Threaded for regulators NPS 2 and smaller; flanged for regulators NPS 2-1/2 and larger.

- a. Body and Diaphragm Case: Die-cast aluminum.
- b. Springs: Zinc-plated steel; interchangeable.
- c. Diaphragm Plate: Zinc-plated steel.
- d. Seat Disc: Nitrile rubber.
- e. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
- f. Factory-Applied Finish: Minimum three-layer polyester and polyurethane paint finish.
- g. Regulator may include vent limiting device, instead of vent connection, if approved by authorities having jurisdiction.
- h. Maximum Inlet Pressure: 2 psig.

2.7 SEISMIC PROVISIONS

Provide earthquake automatic gas shutoff valve conforming to ASCE 25-16, SMACNA 1981 or excess flow valve (EFV) conforming with ANSI Z21.93/CSA 6.30 and UL listed or AGA listed or International Association of Plumbing and Mechanical Officials (IAPMO) listed. The earthquake valve may be either pendulum or ball construction with remote , pneumatic electronic or electric actuator. The EFV may be either a bypass (automatic reset) or a non-bypass type (manual reset).

2.8 BOLTING (BOLTS AND NUTS)

Stainless steel bolting; [ASTM A193/A193M](#), Grade B8M or B8MA, Type 316, for bolts; and [ASTM A194/A194M](#), Grade 8M, Type 316, for nuts. Dimensions of bolts, studs, and nuts must conform with [ASME B18.2.1](#) and [ASME B18.2.2](#) with coarse threads conforming to [ASME B1.1](#), with Class 2A fit for bolts and studs and Class 2B fit for nuts. Bolts or bolt-studs must extend through the nuts and may have reduced shanks of a diameter not less than the diameter at root of threads. Bolts must have American Standard regular square or heavy hexagon heads; nuts must be American Standard heavy semifinished hexagonal.

2.9 GASKETS

Fluorinated elastomer, compatible with flange faces.

2.10 IDENTIFICATION FOR ABOVEGROUND PIPING

[MIL-STD-101](#) for legends and type and size of characters. For pipes [3/4 inch](#) od and larger, provide printed legends to identify contents of pipes and arrows to show direction of flow. Color code label backgrounds to signify levels of hazard. Make labels of plastic sheet with pressure-sensitive adhesive suitable for the intended application. For pipes smaller than [3/4 inch](#) od, provide brass identification tags [1 1/2 inches](#) in diameter with legends in depressed black-filled characters.

2.10.1 Identification for Underground Utilities

Detectable Warning Tape: Acid- and alkali-resistant, PE film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored yellow.

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy or areas of conflict before performing the work.

3.2 PREPARATION

- a. Close equipment shutoff valves before turning off natural gas to premises or piping section.
- b. Inspect natural-gas piping according to NFPA 54 and the International Fuel Gas Code to determine that natural-gas utilization devices are turned off in piping section affected.
- c. Comply with NFPA 54 and the International Fuel Gas Code requirements for prevention of accidental ignition.

3.3 GAS PIPING SYSTEM

Provide a gas piping system from the point of delivery, defined as the outlet of the shutoff valve, to the connections to each gas utilization

device that is in compliance with NFPA 54.

3.3.1 Protection and Cleaning of Materials and Components

Protect equipment, pipe, and tube openings by closing with caps or plugs during installation. At the completion of all work, thoroughly clean the entire system.

3.3.2 Workmanship and Defects

Piping, tubing and fittings must be clear and free of cutting burrs and defects in structure or threading and must be thoroughly brushed and chip-and scale-blown. Repair of defects in piping, tubing or fittings is not allowed; replace defective items when found.

3.4 PROTECTIVE COVERING

3.4.1 Aboveground Metallic Piping Systems

3.4.1.1 Ferrous Surfaces

Touch up shop primed surfaces with ferrous metal primer. Solvent clean surfaces that have not been shop primed. Mechanically clean surfaces that contain loose rust, loose mill scale and other foreign substances by power wire brushing and prime with vinyl type wash coat. Finish primed surfaces with two coats of exterior vinyl paint.

3.4.1.2 Nonferrous Surfaces

Do not paint nonferrous surfaces.

3.5 INSTALLATION

Install the gas system in conformance with the manufacturer's recommendations and applicable provisions of NFPA 54 and as indicated. Perform all pipe cutting without damage to the pipe, with an approved type of mechanical cutter, unless otherwise authorized. Use wheel cutters where practicable. On steel pipe 6 inches and larger, an approved gas cutting and beveling machine may be used.

3.5.1 INDOOR PIPING INSTALLATION

- a. Comply with NFPA 54 and the International Fuel Gas Code for installation and purging of natural-gas piping.
- b. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- c. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.
- d. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- e. Install piping indicated to be exposed and piping in equipment rooms

and service areas at right angles or parallel to building walls.
Diagonal runs are prohibited unless specifically indicated otherwise.

- f. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- g. Locate valves for easy access.
- h. Install natural-gas piping at uniform grade of 2 percent down toward drip and sediment traps.
- i. Install piping free of sags and bends.
- j. Install fittings for changes in direction and branch connections.
- k. Verify final equipment locations for roughing-in.
- l. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.
- m. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.
 - 1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.
- n. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.
- o. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels unless indicated to be exposed to view.
- p. Concealed Location Installations: Except as specified below, install concealed natural-gas piping and piping installed under the building in containment conduit constructed of steel pipe with welded joints. Install a vent pipe from containment conduit to outdoors and terminate with weatherproof vent cap.
 - 1. Above Accessible Ceilings: Natural-gas piping, fittings, valves, and regulators may be installed in accessible spaces without containment conduit.
 - 2. In Floors: Install natural-gas piping with welded or brazed joints and protective coating in cast-in-place concrete floors. Cover piping to be cast in concrete slabs with minimum of 1-1/2 inches of concrete. Piping may not be in physical contact with other metallic structures such as reinforcing rods or electrically neutral conductors. Do not embed piping in concrete slabs containing quick-set additives or cinder aggregate.
 - 3. In Floor Channels: Install natural-gas piping in floor channels. Channels must have cover and be open to space above cover for

ventilation.

4. In Walls or Partitions: Protect tubing installed inside partitions or hollow walls from physical damage using steel striker barriers at rigid supports.

- a. Exception: Tubing passing through partitions or walls does not require striker barriers.

5. Prohibited Locations:

- a. Do not install natural-gas piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.

- b. Do not install natural-gas piping in solid walls or partitions.

- q. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.
 - r. Connect branch piping from top or side of horizontal piping.
 - s. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required at flanged connections.
 - t. Do not use natural-gas piping as grounding electrode.
 - u. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.
 - v. Install pressure gage upstream and downstream from each line regulator.

3.5.2 Final Gas Connections

- a. Connect to utility's gas main according to utility's procedures and requirements.
 - b. Install natural-gas piping electrically continuous, and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.
 - c. Install piping adjacent to appliances to allow service and maintenance of appliances.
 - d. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.
 - e. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

3.5.3 Seismic Requirements

Support and brace piping and attached valves to resist seismic loads in conformance with [ASCE 25-16](#).

3.6 PIPE JOINTS

Design and install pipe joints to effectively sustain the longitudinal pull-out forces caused by contraction of the piping or superimposed loads.

- a. Ream ends of pipes and tubes and remove burrs.
- b. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- c. Threaded Joints:
 1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
 2. Cut threads full and clean using sharp dies.
 3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
 4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
 5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- d. Welded Joints:
 1. Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators.
 2. Bevel plain ends of steel pipe.
 3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.
- e. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter.
- f. Flanged Joints: Install gasket material, size, type, and thickness appropriate for natural-gas service. Install gasket concentrically positioned.
- g. Flared Joints: Cut tubing with roll cutting tool. Flare tube end with tool to result in flare dimensions complying with SAE J513. Tighten finger tight, then use wrench. Do not overtighten.

3.7 PIPE SLEEVES

Provide pipes passing through concrete or masonry walls or concrete floors or roofs with pipe sleeves fitted into place at the time of construction. Do not install sleeves in structural members except where indicated or approved. Make all rectangular and square openings as detailed. Extend each sleeve through its respective wall, floor or roof, and cut flush with each surface, except in mechanical room floors not located on grade where clamping flanges or riser pipe clamps are used. Extend sleeves in mechanical room floors above grade at least 4 inches above finish floor. Unless otherwise indicated, use sleeves large enough to provide a minimum

clearance of 1/4 inch all around the pipe. Provide steel pipe for sleeves in bearing walls, waterproofing membrane floors, and wet areas. Provide sleeves in nonbearing walls, floors, or ceilings of steel pipe, galvanized sheet metal with lock-type longitudinal seam, or moisture-resistant fiber or plastic. For penetrations of fire walls, fire partitions and floors which are not on grade, seal the annular space between the pipe and sleeve with fire-stopping material and sealant that meet the requirement of Section 07 84 00 FIRESTOPPING.

3.8 PIPES PENETRATING WATERPROOFING MEMBRANES

Install pipes penetrating waterproofing membranes as specified in Section 22 00 00 PLUMBING, GENERAL PURPOSE.

3.9 FIRE SEAL

Fire seal all penetrations of fire rated partitions, walls and floors in accordance with Section 07 84 00 FIRESTOPPING.

3.10 ESCUTCHEONS

Provide escutcheons for all finished surfaces where gas piping passes through floors, walls, or ceilings except in boiler, utility, or equipment rooms.

3.11 SPECIAL REQUIREMENTS

Provide drips, grading of the lines, freeze protection, and branch outlet locations as shown and conforming to the requirements of NFPA 54.

3.12 BUILDING STRUCTURE

Do not weaken any building structure by the installation of any gas piping. Do not cut or notch beams, joists or columns. Attach piping supports to metal decking. Do not attach supports to the underside of concrete filled floors or concrete roof decks unless approved by the Contracting Officer.

3.13 PIPING SYSTEM SUPPORTS

Comply with requirements for pipe hangers and supports specified in Section 22 00 00.

Support gas piping systems in buildings with pipe hooks, metal pipe straps, bands or hangers suitable for the size of piping or tubing. Do not support any gas piping system by other piping. Conform spacing of supports in gas piping and tubing installations to the requirements of NFPA 54. Conform the selection and application of supports in gas piping and tubing installations to the requirements of MSS SP-58. In the support of multiple pipe runs on a common base member, use a clip or clamp where each pipe crosses the base support member. Spacing of the base support members is not to exceed the hanger and support spacing required for any of the individual pipes in the multiple pipe run. Rigidly connect the clips or clamps to the common base member. Provide a clearance of 1/8 inch between the pipe and clip or clamp for all piping which may be subjected to thermal expansion.

- a. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:

1. NPS 1 and Smaller: Maximum span, 96 inches; minimum rod size, 3/8 inch.
 2. NPS 1-1/4: Maximum span, 108 inches; minimum rod size, 3/8 inch.
 3. NPS 1-1/2 and NPS 2: Maximum span, 108 inches; minimum rod size, 3/8 inch.
 4. NPS 2-1/2 to NPS 3-1/2: Maximum span, 10 feet; minimum rod size, 1/2 inch.
 5. NPS 4 and Larger: Maximum span, 10 feet; minimum rod size, 5/8 inch.
- b. Install hangers for horizontal, corrugated stainless-steel tubing with the following maximum spacing and minimum rod sizes:
1. NPS 3/8: Maximum span, 48 inches; minimum rod size, 3/8 inch.
 2. NPS 1/2: Maximum span, 72 inches; minimum rod size, 3/8 inch.
 3. NPS 3/4 and Larger: Maximum span, 96 inches; minimum rod size, 3/8 inch.

3.14 ELECTRICAL BONDING AND GROUNDING

Provide a gas piping system within the building that is electrically continuous and bonded to a grounding electrode as required by NFPA 54, and NFPA 70.

3.15 SHUTOFF VALVE

Provide stop valve on service branch at connection to main and shut-off valve on riser outside of building.

3.16 LINE AND APPLIANCE PRESSURE REGULATORS

Install line pressure regulators and appliance regulators in accordance with the manufacturer's requirements and in accordance with NFPA 54. Install each regulator in an accessible location and install shutoff valves ahead of each line and appliance regulator to allow for maintenance. Where vent limiting devices are not included in the regulators, install a vent pipe to the exterior of the building. Terminate all service regulator vents and relief vents in the outside air in rain and insect resistant fittings. Locate the open end of the vent where gas can escape freely into the atmosphere, away from any openings into the building and above areas subject to flooding.

3.17 TESTING

Submit test procedures and reports in booklet form tabulating test and measurements performed; dated after award of this contract, and stating the Contractor's name and address, the project name and location, and a list of the specific requirements which are being certified. Test entire gas piping system to ensure that it is gastight prior to putting into service. Prior to testing, purge the system, clean, and clear all foreign material. Test each joint with an approved gas detector, soap and water, or an equivalent nonflammable solution. Inspect and test each valve in

conformance with **API Std 598** and **API Std 607**. Complete testing before any work is covered, enclosed, or concealed, and perform with due regard for the safety of employees and the public during the test. Install bulkheads, anchorage and bracing suitably designed to resist test pressures if necessary, and as directed and or approved by the Contracting Officer. Do not use oxygen as a testing medium.

3.17.1 Pressure Tests

Submit test procedures and reports in booklet form tabulating test and measurements performed; dated after award of this contract, and stating the Contractor's name and address, the project name and location, and a list of the specific requirements which are being certified. Before appliances are connected, test by filling the piping systems with air or an inert gas to withstand a minimum pressure of 3 pounds gauge for a period of not less than 10 minutes as specified in **NFPA 54** without showing any drop in pressure. Do not use Oxygen for test. Measure pressure with a mercury manometer, slope gauge, or an equivalent device calibrated to be read in increments of not greater than 0.1 pound. Isolate the source of pressure before the pressure tests are made.

3.17.2 Test With Gas

Before turning on gas under pressure into any piping, close all openings from which gas can escape. Immediately after turning on the gas, check the piping system for leakage by using a laboratory-certified gas meter, an appliance orifice, a manometer, or equivalent device. Conform all testing to the requirements of **NFPA 54**. If leakage is recorded, shut off the gas supply, repair the leak, and repeat the tests until all leaks have been stopped.

3.17.3 Purging

After testing is completed, and before connecting any appliances, fully purge all gas piping. Do not purge piping into the combustion chamber of an appliance. Do not purge the open end of piping systems into confined spaces or areas where there are ignition sources unless the safety precautions recommended in **NFPA 54** are followed.

3.17.4 Labor, Materials and Equipment

Furnish all labor, materials and equipment necessary for conducting the testing and purging.

3.18 DEMONSTRATION

Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain earthquake valves.

3.19 PIPING SCHEDULES

3.19.1 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES LESS THAN 0.5 PSIG

Aboveground, branch piping NPS 1 and smaller shall be corrugated stainless-steel tubing with mechanical fittings having socket or threaded ends to match adjacent piping.

3.19.2 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES MORE THAN 0.5 PSIG AND LESS THAN 2 PSIG

Aboveground, branch piping NPS 2 and smaller shall be steel pipe with steel threaded fittings and threaded joints.

3.19.3 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

- a. Valves for pipe sizes NPS 2 and smaller at service meter shall be one of the following:
 - 1. Two-piece, full-port, bronze ball valves with bronze trim.
 - 2. Bronze plug valve.
- b. Distribution piping valves for pipe sizes NPS 2 and smaller shall be the following:
 - 1. Two-piece, full-port, bronze ball valves with bronze trim.
 - 2. Bronze plug valve.
- c. Valves in branch piping for single appliance shall be the following:
 - 1. Two-piece, full-port, bronze ball valves with bronze trim.
 - 2. Bronze plug valve.

-- End of Section --

SECTION 23 21 13.00 20

LOW TEMPERATURE WATER (LTW) HEATING SYSTEM

04/06, CHG 2: 11/19

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.1	(2003; R 2018) Unified Inch Screw Threads (UN and UNR Thread Form)
ASME B1.20.1	(2013; R 2018) Pipe Threads, General Purpose (Inch)
ASME B16.1	(2020) Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250
ASME B16.3	(2021) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.5	(2020) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B16.9	(2018) Factory-Made Wrought Butt welding Fittings
ASME B16.11	(2022) Forged Fittings, Socket-Welding and Threaded
ASME B16.18	(2021) Cast Copper Alloy Solder Joint Pressure Fittings
ASME B16.21	(2021) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.22	(2021) Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B16.24	(2022) Cast Copper Alloy Pipe Flanges, Flanged Fittings, and Valves Classes 150, 300, 600, 900, 1500, and 2500
ASME B16.34	(2021) Valves - Flanged, Threaded and Welding End
ASME B16.39	(2020) Standard for Malleable Iron Threaded Pipe Unions; Classes 150, 250, and 300
ASME B18.2.2	(2022) Nuts for General Applications: Machine Screw Nuts, and Hex, Square, Hex

Flange, and Coupling Nuts (Inch Series)

ASME B31.9

(2020) Building Services Piping

ASME B40.100

(2013) Pressure Gauges and Gauge
Attachments

ASME BPVC SEC VIII D1

(2019) BPVC Section VIII-Rules for
Construction of Pressure Vessels Division 1

AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)

ASSE 1003

(2020) Performance Requirements for Water
Pressure Reducing Valves for Domestic
Water Distribution Systems - (ANSI
approved 2010)

ASSE 1017

(2009) Performance Requirements for
Temperature Actuated Mixing Valves for Hot
Water Distribution Systems - (ANSI
approved 2010)

AMERICAN WELDING SOCIETY (AWS)

AWS Z49.1

(2021) Safety in Welding and Cutting and
Allied Processes

ASTM INTERNATIONAL (ASTM)

ASTM A53/A53M

(2022) Standard Specification for Pipe,
Steel, Black and Hot-Dipped, Zinc-Coated,
Welded and Seamless

ASTM A123/A123M

(2017) Standard Specification for Zinc
(Hot-Dip Galvanized) Coatings on Iron and
Steel Products

ASTM A194/A194M

(2022) Standard Specification for Carbon
Steel, Alloy Steel, and Stainless Steel
Nuts for Bolts for High-Pressure or
High-Temperature Service, or Both

ASTM A307

(2021) Standard Specification for Carbon
Steel Bolts, Studs, and Threaded Rod 60
000 PSI Tensile Strength

ASTM B32

(2020) Standard Specification for Solder
Metal

ASTM B88

(2022) Standard Specification for Seamless
Copper Water Tube

ASTM F1007

(2018; R 2022) Standard Specification for
Pipeline Expansion Joints of the Packed
Slip Type for Marine Application

ASTM F1120

(1987; R 2019) Standard Specification for
Circular Metallic Bellows Type Expansion
Joints for Piping Applications

COPPER DEVELOPMENT ASSOCIATION (CDA)

CDA A4015 (2016; 14/17) Copper Tube Handbook

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS
INDUSTRY (MSS)

MSS SP-58 (2018) Pipe Hangers and Supports -
Materials, Design and Manufacture,
Selection, Application, and Installation

MSS SP-67 (2022) Butterfly Valves

MSS SP-69 (2003; Notice 2012) Pipe Hangers and
Supports - Selection and Application (ANSI
Approved American National Standard)

MSS SP-70 (2011) Gray Iron Gate Valves, Flanged and
Threaded Ends

MSS SP-72 (2010a) Ball Valves with Flanged or
Butt-Welding Ends for General Service

MSS SP-80 (2019) Bronze Gate, Globe, Angle and Check
Valves

MSS SP-85 (2011) Gray Iron Globe & Angle Valves
Flanged and Threaded Ends

MSS SP-110 (2010) Ball Valves Threaded,
Socket-Welding, Solder Joint, Grooved and
Flared Ends

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 2 (2000; R 2020) Industrial Control and
Systems Controllers, Contactors, and
Overload Relays Rated 600 V

NEMA ICS 6 (1993; R 2016) Industrial Control and
Systems: Enclosures

NEMA MG 1 (2021) Motors and Generators

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-V-12003 (1980; Rev F; Am 1; CANC Notice 1) Valves,
Plug, Cast-Iron or Steel, Manually
Operated

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

CID A-A-1689 (Rev B) Tape, Pressure-Sensitive Adhesive,
(Plastic Film)

CID A-A-50560 (Basic) Pumps, Centrifugal, Water
Circulating, Electric-Motor-Driven

CID A-A-59617 (Basic, Notice 1) Unions, Brass or Bronze,
Threaded Pipe Connections and Solder-Joint
Tube Connections

FS WW-S-2739 (Basic; Notice 1; Notice 2) Strainers,
Sediment: Pipeline, Water, Air, Gas, Oil,
or Steam

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.144 Safety Color Code for Marking Physical
Hazards

29 CFR 1910.219 Mechanical Power Transmission Apparatus

1.2 RELATED REQUIREMENTS

Section 23 03 00.00 20 BASIC MECHANICAL MATERIALS AND METHODS applies to this section with additions and modifications specified herein.

1.3 SYSTEM DESCRIPTION

Except as specified otherwise, equipment and piping components shall be suitable for use in low temperature water heating system. Except as modified herein, the pressure temperature limitations shall be as specified in the referenced standards and specifications. Pressures in this specification are pressures in pounds per square inch above atmospheric pressure, and temperatures are in degrees Fahrenheit (F).

1.3.1 Hot Water Heating System

Submit plan, elevations, dimensions, capacities, and ratings. Include the following:

- a. Unit heaters
- b. Convectors
- c. Finned tube radiators
- d. Pumps
- e. Valves
- f. Expansion tanks
- g. Flow measuring equipment
- h. Backflow preventer
- i. Air separating tank
- j. Boilers

1.4 SUBMITTALS

Government approval is required for submittals. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Hot water heating system

SD-03 Product Data

Pumps

Include pump speed and characteristic curve for performance of impeller selected for each pump. Curves shall indicate capacity vs head, efficiency, and brake power for full range, from shut-off to free delivery.

Expansion tanks

Backflow preventers

External air separation tanks

Hot water heating pipe

SD-06 Test Reports

Hydrostatic test of piping system

Auxiliary equipment and accessory tests

Submit test reports in accordance with the paragraph entitled "Field Quality Control."

SD-07 Certificates

Backflow preventer certification

Report of prior installations

Welding procedures

Welder's qualifications

SD-10 Operation and Maintenance Data

1.5 QUALITY ASSURANCE

1.5.1 Standard Commercial Product for Terminal Units

Terminal units provided shall comply with features called out in this specification and shall be the manufacturer's standard commercial product. Additional or better features which are not prohibited by this specification but which are a part of the manufacturer's standard commercial product, shall be included in the terminal units being furnished. A standard commercial product is a product which has been sold or is currently being offered for sale, on the commercial market through advertisements or manufacturer's catalogs, or brochures. Provide Institute of Boiler and Radiator Manufacturer (IBR) or Steel Boiler Institute (SBI) rating for required capacity.

1.5.2 Welding

1.5.2.1 Report of Prior Installations

Submit a Certificate of Full Approval or a current Certificate of Approval for each design, size, and make of backflow preventer being provided for the project. Certificate shall be from the Foundation for Cross-Connection Control and Hydraulic Research, University of Southern California, and shall attest that this design, size, and make of backflow preventer has satisfactorily passed the complete sequence of performance testing and evaluation for the respective level of approval. A Certificate of Provisional Approval is not acceptable in lieu of the above.

1.5.2.2 Welding Procedures

Before performing welding, submit three copies of welding procedure specification for all metals to be used in the work, together with proof of welder's qualification as outlines in [ASME B31.9](#).

1.5.2.3 Welder's Qualifications

Before welder or operator performs welding, submit three copies of Welder's Performance Qualification Record in conformance with [ASME B31.9](#) showing that the welder was tested under the approved procedure specification submitted by the Contractor. In addition, submit each welder's assigned number, letter, or symbol used to identify the work of the welder.

1.5.2.4 Identification of Welder's Work

Ensure that each welder's assigned number, letter or symbol is affixed immediately upon completion of the weld. To welders making defective welds after passing a qualification test, give a requalification test. Upon failing to pass the test, do not permit welder to work in this contract.

1.5.2.5 Previous Qualifications

Welding procedures, welders, and welding operators previously qualified by test may be accepted for this contract without requalification subject to the approval and provided that all the conditions specified in [ASME B31.9](#) are met before a procedure can be used.

1.5.3 Brazing and Soldering

1.5.3.1 Brazing Procedure

[ASME B31.9](#). Brazing procedure for joints shall be as outlined in [CDA A4015](#).

1.5.3.2 Soldering, Soldering Preparation, and Procedures for Joints

[ASME B31.9](#) and as outlined in [CDA A4015](#).

1.5.4 Backflow Preventer Certification

Submit a Certificate of Full Approval or a current Certificate of Approval for backflow preventers.

1.6 SAFETY STANDARDS

1.6.1 Welding

Safety in welding and cutting of pipe shall conform to AWS Z49.1.

1.6.2 Guards

Couplings, motor shafts, gears and other moving parts shall be guarded, in accordance with OSHA 29 CFR 1910.219. Guards shall be cast iron or expanded metal. Guard parts shall be rigid and removable without disassembling the guarded unit.

PART 2 PRODUCTS

2.1 PIPE AND FITTINGS

2.1.1 Hot Water Heating Pipe (Supply and Return)

ASTM A53/A53M electric resistance welded or seamless Schedule 40 steel pipe or ASTM B88 Type V hard drawn Copper tubing.

2.1.2 Fittings

Provide fittings compatible with the pipe being provided and shall conform to the following requirements.

2.1.2.1 Steel or Malleable Iron Pipe

Sizes 1/8 to 2 inches. ASME B16.11 steel socket welding or screwed type or ASME B16.3 for screwed type malleable iron fittings.

2.1.2.2 Steel, Cast Iron, or Bronze

Sizes 2 1/2 inches and above. Steel fitting butt welding type ASME B16.9 or ASME B16.5 flanged type. Cast iron fittings flanged type ASME B16.1. Bronze fittings up to 8 inch size flanged type ASME B16.24.

2.1.2.3 Fittings for Copper Tubing

ASME B16.18 cast bronze solder joint type or ASME B16.22 wrought copper solder joint type. Fittings may be flared or compression joint type.

2.1.3 Unions

2.1.3.1 Steel Pipe

Provide ASME B16.39, malleable iron unions, threaded connections.

2.1.3.2 Copper Tubing

Provide CID A-A-59617, bronze unions, solder joint end.

2.1.3.3 Dielectric Union

Provide insulated union with galvanized steel female pipe-threaded end and a copper solder joint end conforming with ASME B16.39, Class 1, dimensional, strength and pressure requirements. Union shall have a water-impervious insulation barrier capable of limiting galvanic current

to one percent of the short-circuit current in a corresponding bimetallic joint. When dry, insulation barrier shall be able to withstand a 600-volt breakdown test.

2.1.4 Flanges

Remove raised faces when used with flanges having a flat face.

2.1.4.1 Steel Flanges

ASME B16.5 forged steel, welding type.

2.1.4.2 Cast Iron Screwed Flanges

ASME B16.1.

2.1.4.3 Bronze Screwed Flanges

ASME B16.24.

2.1.5 Drains and Overflows

2.1.5.1 Steel Pipe

ASTM A53/A53M, Seamless Schedule 40, Malleable iron or forged steel fittings, screwed or welded joints.

2.1.5.2 Copper Tubing

ASTM B88, Type L, hard drawn, cast brass or wrought copper fittings, Grade Sb5 solder joints.

2.1.6 Valves

Valves shall have rising stems and shall open when turned counterclockwise.

2.1.6.1 Gate Valves

- a. Bronze Gate Valves: MSS SP-80, 2 inches and smaller, wedge disc, inside screw type not less than Class 150. Use solder joint ends with copper tubing.
- b. Steel Gate Valves: ASME B16.34, provide with open stem and yoke type with solid wedge or flexible wedge disc and heat and corrosion-resistant steel trim.
- c. Cast Iron Gate Valves: MSS SP-70, 2 1/2 inches and larger, open stem and yoke type with bronze trim.

2.1.6.2 Globe and Angle Valves

- a. Bronze Globe and Angle Valves: MSS SP-80, 2 inches and smaller, Class 200, except use Class 150 with solder ends for copper tubing. Valves shall have renewable seat and discs except solder end valves which shall have integral seats.
- b. Steel Globe and Angle Valves: ASME B16.34, provide with heat and corrosion-resistant trim.

- c. Cast Iron Globe and Angle Valves: **MSS SP-85**, 2 1/2 inches and larger, with bronze trim, tapped drains and brass plug.

2.1.6.3 Check Valves

- a. Bronze Check Valves: **MSS SP-80**, 2 inches and smaller, regrinding swing check type, Class 200.
- b. Steel Swing Check Valves: **ASME B16.34**, regrinding swing check type, Class 200.
 - (1) Swing check valves shall have bolted caps.
 - (2) Steel Lift check valves 2 inches and smaller shall have bolted caps. Lift check valves 2 1/2 inches and larger shall have pressure seal caps.
- c. Cast Iron Check Valves: **ASME B16.34**, 2 1/2 inches and larger, bronze trim, non-slam, eccentric disc type for centrifugal pump discharge service.

2.1.6.4 Temperature Regulating Valves

Provide **ASSE 1017** copper alloy body with adjustable range thermostat.

2.1.6.5 Water Pressure-Reducing Valves

ASSE 1003.

2.1.6.6 Plug Valves

MIL-V-12003, except that a replaceable valve seat will not be required. Type I - lubricated, tapered plug valves.

2.1.6.7 Ball Valves

Flanged or butt-welding ends ball valve shall conform to **MSS SP-72**, bronze. Threaded, socket-welding, solder joint, grooved and flared ends shall conform to **MSS SP-110**.

2.1.6.8 Radiator Valves

Radiator valves shall be angle or straightway pattern, with packed or packless bonnet shutoff globe type, designed especially for hot water heating system. Valve shall be constructed of brass or bronze or copper alloy conforming to ASTM specifications for materials with non-metallic renewable disc and plastic wheel handle for shutoff service.

2.1.6.9 Flow Control Balancing Valves

Copper alloy or cast iron body, copper alloy or stainless internal working parts, and integral pointer that indicates the degree of valve opening. Valves shall be suitable for 125 psig at 190 degrees F hot water. Valve shall function as a service valve when in fully closed position. Valve body shall have factory-installed tappings for differential pressure meter connections for verification of pressure differential across valve orifice. Meter connections shall have positive check valves or shutoff valves. Each valve shall have metal tag showing the gallons per minute flow for each differential pressure reading.

2.1.6.10 Butterfly Valves

Conform with **MSS SP-67**, Type I - Tight shut off valve, and flanged valve ends. Valve body material shall be **cast iron or bronze** and shall be bubble tight for shutoff at **150 psig**. Flanged and flangeless type valves shall have Type 300 series corrosion resistant steel stems and corrosion resistant or bronze discs with molded elastomer disc seals. Flow conditions shall be for the regulation from maximum flow to complete shutoff by way of throttling effect. Valves shall be provided in closed system. Valves smaller than **8 inches** shall have throttling handles. Valves **8 inches** and larger shall have totally enclosed manual gear operators with adjustable balance return stops and indicators. Valves shall have a minimum of 7 locking positions and shall be suitable for water temperatures up to **200 degrees F**.

2.1.6.11 Butterfly Valves **2 Inches** and Smaller

Valves shall be one-piece and three-piece design with male or female threaded or soldered end connections and shall be bubble tight for shutoff at **150 psig**. Stem and disc assembly shall be of 300 series corrosion resistant steel. Disc seal assembly shall be of 300 series corrosion resistant steel. Disc seal shall be suitable for the liquid being used in the system in which the valve is to be installed. Valves shall be suitable for water temperature up to **200 degrees F** and shall be capable of operating at the rated pressure of **150 psig**. Valves shall be designed for throttling service use by valve lever and indicator adjustment.

2.1.6.12 Relief Valves

Bronze body, teflon seat, stainless steel stem and springs, automatic, direct pressure actuated, capacities ASME certified and labelled.

2.1.6.13 Valve Operating Mechanisms

Provide chainwheels where indicated and as specified.

- a. Chainwheel Operator: Shall be fabricated of cast iron or steel and shall include a wheel, endless chain and a guide to keep the chain on the wheel. Provide galvanized steel endless chain extending to within **3 feet** of the floor.
- b. Extension Stem: Corrosion resisting steel designed for rising and non-rising stems. Provide in length required to connect the valve stem and the handwheel and of sufficient cross section to transfer the torque required to operate the valve.

2.1.6.14 Balancing Valves

Balancing valves shall be calibrated bronze body balancing valves with integral ball valve and venturi or valve orifice and valve body pressure taps for flow measurement based on differential pressure readings. Valve pressure taps and meter connections shall have seals and built-in check valves with threaded connections for a portable meter. Meter shall be provided by the same manufacturer and be capable of reading system pressures and shall meet the requirements of the paragraph entitled "Flow Measuring Equipment." Valves shall have internal seals to prevent leakage around rotating element and be suitable for full shut-off rated pressure. Valves shall have an operator with integral pointer and memory stop.

Balancing valves shall be selected for the required flows as indicated on the plans.

2.1.7 End Connections

2.1.7.1 Flexible Connectors

Provide flexible pipe connectors on piping connected to equipment. Flexible section shall consist of rubber, tetrafluoroethylene resin, corrosion-resistant steel, bronze, monel, or galvanized steel. Material provided and configuration shall be suitable for pressure and temperature and circulating medium. Flexible section shall have flanged ends and shall be suitable for service intended. Flexible section may be reinforced with metal retaining rings, with built-in braided wire reinforcement and restriction bolts or with wire braid cover suitable for service intended.

2.1.7.2 Steel Piping

Screwed or socket welded for 2 inches and smaller and flanged or butt welded for 2 1/2 inches and larger.

- a. Screwed Joints With Taper Threads: ASME B1.20.1.
- b. Flanged Joints: Bolting and gaskets shall be as follows:
 - (1) Bolting: Bolt and stud material ASTM A307, Grade B, and nut material ASTM A194/A194M, Grade 2. Bolt, stud, and nut dimensions ASME B18.2.2 threads ASME B1.1 coarse type with Class 2A fit for bolts and studs, and Class 2B fit for nuts. Bolts or bolt studs shall extend completely through the nuts and may have reduced shanks of a diameter not less than the diameter at root of threads. Carbon steel bolts shall have American Standard regular square or heavy hexagon heads and shall have American Standard heavy semifinished hexagonal nuts conforming to ASME B18.2.2.
 - (2) Gaskets: ASME B16.21, Nonasbestos compressed material 1/16 inch thickness full face or self-centering flat ring type and suitable for pressure and temperature of the piping system.
- c. Butt Weld Joints: ASME B31.9. Backing rings shall conform to ASME B31.9. Ferrous rings shall not exceed 0.05 percent sulfur; for alloy pipe, backing rings shall be of material compatible with the chemical composition of the parts to be welded and preferably of the same composition. Provide continuous machined or split band backing rings.
- d. Socket Weld Joints: ASME B31.9.

2.1.7.3 Joints for Copper Tubing

- a. Solder conforming to ASTM B32 alloy grade Sb5 or Sn96. Solder and flux shall be lead free (less than 0.2 percent of lead).
- b. Copper Tube Extracted Joint: An extracted mechanical tee joint may be made in copper tube. Make joint with an appropriate tool by drilling a pilot hole and drawing out the tube surface to form a collar having a minimum height of three times the thickness of the tube wall. To prevent the branch tube from being inserted beyond the depth of the

extracted joint, provide dimpled depth stops. Notch the branch tube for proper penetration into fitting to assure a free flow joint. Braze extracted joints using a copper phosphorous classification brazing filler metal. Soldered joints shall not be permitted.

2.1.8 Expansion Joints

2.1.8.1 Packless Type

Provide [ASTM F1120](#), Type III with fabricated corrosion-resistant steel bellows.

2.1.8.2 Guided Slip-Tube Type

Provide [ASTM F1007](#), Type IV internally-externally guided, injected semiplastic type packing.

2.1.9 Instrumentation

2.1.9.1 Pressure and Vacuum Gauges

Provide [ASME B40.100](#) with restrictor.

2.1.9.2 Indicating Thermometers

Thermometers shall be dial type with an adjustable angle suitable for the service. Provide thermowell sized for each thermometer in accordance with the thermowell specification. Fluid-filled thermometers (mercury is not acceptable) shall have a nominal scale diameter of [5 inches](#). Construction shall be stainless-steel case with molded glass cover, stainless-steel stem and bulb. Stem shall be straight, length as required to fit well. Bimetal thermometers shall have a scale diameter of [3 1/2 inches](#). Case shall be hermetic. Case and stem shall be constructed of stainless steel. Bimetal stem shall be straight and of a length as required to fit the well.

2.1.9.3 Pressure/Temperature Test Ports

Pressure/Temperature Test Ports shall have brass body and EPDM and/or Neoprene valve seals. Ports shall be rated for service between [35 and 275 degrees F](#) and up to [500 psig](#). Ports shall be provided in lengths appropriate for the insulation thickness specified in Section [23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS](#) and installed to allow a minimum of [12 inches](#) of access for probe insertion. Provide with screw-on cap attached with a strap or chain to prevent loss when removed. Ports shall be [1/4 inch NPT](#) and accept [1/8 inch](#) diameter probes.

2.1.10 Miscellaneous Pipeline Components

2.1.10.1 Air Vent

Provide float type air vent in hydronic systems. Vent shall be constructed of brass or semi-steel body, copper float, and stainless steel valve and valve seat. Design air vent to suit system operating temperature and pressure. Provide isolating valve to permit service without draining the system. Pipe discharge of vent to a drain.

2.1.10.2 Strainers

Strainers for classes 125 and 250 piping in IPS 1/2 to 8 inches, inclusive, [FS WW-S-2739](#) and locate as indicated.

2.1.10.3 Hangers and Supports

Design and fabrication of pipe hangers, supports, and welding attachments shall conform to [MSS SP-58](#) and [ASME B31.9](#). Hanger types and supports for bare and covered pipe shall conform to [MSS SP-69](#) for the temperature range. If ferrous materials are used, provide hot dipped galvanized hangers, inserts and supports.

2.1.10.4 Pipe Sleeves

Sleeves in masonry and concrete walls, floors, and roof slabs shall be [ASTM A53/A53M](#), Schedule 40 or Standard Weight, hot-dip galvanized steel ductile-iron or cast-iron pipe. Sleeves in partitions shall be zinc-coated sheet steel having a nominal weight of not less than [0.906 pound per square foot](#).

2.1.10.5 Escutcheon Plates

Provide one piece or split hinge metal plates for piping passing through floors, walls, and ceilings in exposed spaces. Provide polished stainless steel plates or chromium-plated finish on copper alloy plates in finished spaces and paint finish on metal plates in unfinished spaces.

2.2 CENTRAL MECHANICAL EQUIPMENT

2.2.1 Boilers

Provide as specified

2.3 PIPING SYSTEM EQUIPMENT

2.3.1 Pumps

Provide hot water circulating pumps, [CID A-A-50560](#), Service A. Pump casing and flange shall be made of close-grained cast iron. Shaft shall be carbon or alloy steel with lubricated bearings and impeller shall be bronze. Select pumps so that the operating point on selected impeller-curve will lie at or to the left of shutoff side of, and not more than 5 percent below, point of maximum efficiency for impeller. Provide motors of [open, splash proof or totally enclosed](#) type conforming to [NEMA MG 1](#) and suitable for electrical characteristic as indicated. Motor starters shall conform to [NEMA ICS 2](#) manual part-windtype with [NEMA ICS 6](#) watertight enclosure.

2.3.2 Expansion Tanks

Provide welded steel, constructed and tested hydrostatically in accordance with [ASME BPVC SEC VIII D1](#). Tank shall be equipped with all necessary fittings. The tank and fittings shall be pressure rated at least equal to the test pressure of the total system. Zinc coat the tank inside and out after fabrication by the hot dip process [ASTM A123/A123M](#).

2.3.3 External Air Separation Tanks

Provide tank constructed of steel, designed for not less than 75 psig, and constructed and tested in accordance with the requirements of ASME BPVC SEC VIII D1. Provide tangential inlet and outlet connections, flanged for sizes 2 1/2 inches and larger. Each unit shall have an internal design suitable for creating the required vortex and subsequent air separation. Provide with automatic air release device and galvanized steel strainer. Provide a blow down connection with a gate valve and piped to nearest floor drain.

2.3.4 Backflow Preventers

Reduced pressure principle type. Furnish proof that each make, model/design, and size of backflow preventer being furnished for the project is approved by and has a current "Certificate of Approval" from the local code. Listing of a particular make, model/design, and size in the current local code will be acceptable as the required proof.

2.4 TERMINAL UNITS

2.4.1 Unit Heaters

Provide hot water unit heaters as specified in Section 23 82 00.00 20
TERMINAL HEATING UNITS.

2.5 ELECTRICAL EQUIPMENT

Provide complete with motors, motor starters, thermal overload protection, and controls. Equipment and wiring shall be in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

2.6 CONTROLS

Provide controls as specified

2.7 INSULATION

Provide shop and field applied insulation as specified in Section 23 07 00
THERMAL INSULATION FOR MECHANICAL SYSTEMS.

2.8 ASBESTOS PROHIBITION

Asbestos and asbestos containing products are prohibited.

PART 3 EXECUTION

3.1 PREPARATION

Provide storage for equipment and material at the project site. All parts shall be readily accessible for inspection, repair, and renewal. Protect material and equipment from the weather.

3.2 INSTALLATION

Piping fabrication, assembly, welding, soldering, and brazing shall conform to ASME B31.9. Piping shall follow the general arrangement shown. Route piping and equipment within buildings out of the way of

lighting fixtures and doors, windows, and other openings. Run overhead piping in buildings in inconspicuous positions. Provide adequate clearances from walls, ceilings, and floors to permit welding of joints and application of insulation. Make provision for expansion and contraction of pipe lines. Make changes in size of water lines with reducing fittings. Do not bury, conceal, or insulate until piping has been inspected, tested, and approved. Do not run piping concealed in walls, partitions, underground, or under the floor except as otherwise indicated. Where pipe passes through building structure, locate pipe joints and expansion joints where they may be inspected. Provide flanged joints where necessary for normal maintenance and where required to match valves and equipment. Furnish gaskets, packing, and thread compounds suitable for the service. Provide long radius ells where possible to reduce pressure drops. Pipe bends in lieu of welding fittings may be used where space permits. Pipe bends shall have a uniform radius of at least five times the pipe diameter and shall be free from appreciable flattening, wrinkling, or thinning of the pipe. Do not use mitering of pipe to form elbows, notching straight runs to form full sized tees, or any similar construction. Make branch connections over 2 inches with welding tees except factory made forged welding branch outlets or nozzles having integral reinforcements conforming to ASME B31.9 may be used, provided the nominal diameter of the branch is at least one pipe size less than the nominal diameter of the run. Branch connections 2 inches and under can be threaded or welded. Run vertical piping plumb and straight and parallel to walls. Provide sleeves for lines passing through building structure. Provide a fire seal where pipes pass through fire wall, fire partitions, fire rated pipe chase walls, or floors above grade. Install piping connected to equipment with flexibility for thermal stresses and for vibration, and support and anchor so that strain from weight and thermal movement of piping is not imposed on the equipment.

3.2.1 Hangers and Supports

Unless otherwise indicated, horizontal and vertical piping attachments shall conform to MSS SP-58. Band and secure insulation protection shields without damaging pipe insulation. Continuous inserts and expansion bolts may be used.

3.2.2 Grading of Pipe Lines

Unless otherwise indicated, install horizontal lines of hot water piping to grade down in the direction of flow with a pitch of not less than one inch in 30 feet, except in loop mains and main headers where the flow may be in either direction.

3.2.3 Pipe Sleeves

Provide sleeves where pipes and tubing pass through masonry or concrete walls, floors, roof, and partitions. Annular space between pipe, tubing, or insulation and the sleeve shall not be less than 1/4 inch. Hold sleeves securely in proper position and location before and during construction. Sleeves shall be of sufficient length to pass through entire thickness of walls, partitions, or slabs. Sleeves in floor slabs shall extend 2 inches above finished floor. Firmly pack space between pipe or tubing and sleeve with oakum and caulk on both ends of the sleeve with plastic waterproof cement which will dry to a firm but pliable mass, or provide a segmented elastomeric seal. Seal both ends of penetrations through fire walls and fire floors to maintain fire resistive integrity with UL listed fill, void, or cavity material.

3.2.4 Flashing for Buildings

Provide flashing where pipes pass through building roofs, and make outside walls tight and waterproof.

3.2.5 Unions and Flanges

Provide unions and flanges to permit easy disconnection of piping and apparatus. Each connection having a screwed-end valve shall have a union. Place unions and flanges no farther apart than 100 feet. Install unions downstream of valves and at equipment or apparatus connections. Provide unions on piping under 2 inches in diameter, and provide flanges on piping 2 inches and over in diameter. Provide dielectric unions or flanges between ferrous and non-ferrous piping, equipment, and fittings; except that bronze valves and fittings may be used without dielectric couplings for ferrous-to-ferrous or non-ferrous-to-non-ferrous connections.

3.2.6 Connections for Future Equipment

Locate capped or plugged outlets for connections to future equipment as indicated.

3.2.7 Changes in Pipe Size

Provide reducing fittings for changes in pipe size; reducing bushings are not permitted. In horizontal lines, provide eccentric reducing fittings to maintain the top of the lines in the same plane.

3.2.8 Cleaning of Pipe

Thoroughly clean each section of pipe, fittings, and valves free of foreign matter before erection. Prior to erection, hold each piece of pipe in an inclined position and tap along its full length to loosen sand, mill scale and other foreign matter. For pipe 2 inches and larger, draw wire brush, of a diameter larger than that of the inside of the pipe, several times through the entire length of pipe. Before making final connections to apparatus, wash out interior of piping thoroughly with water. Plug or cap open ends of mains during shutdown periods. Do not leave lines open where foreign matter might enter the pipe.

3.2.9 Valves

Install valves in conformance with ASME B31.9. Provide gate valves unless otherwise directed. Install valves with stems horizontal or above. Locate or equip stop valves to permit operation from floor level, or provide with safe access in the form of walkways or ladders. Install valves in positions accessible for operation and repair.

3.2.9.1 Globe Valves

Install globe valves so that the pressure is below the disk and the stem horizontal.

3.2.9.2 Radiators Valves

Provide radiator valves on water inlet and balancing valves on water outlet of terminal heating units such as radiation, unit heaters, and fan coil unit.

3.2.9.3 Relief Valves

Provide valves on pressure tanks, low pressure side of reducing valves, heat exchangers, and expansion tanks. Select system relief valve so that capacity is greater than make-up pressure reducing valve capacity. Select equipment relief valve capacity to exceed rating of connected equipment. Pipe relief valve outlet to the nearest floor drain.

3.2.10 Pressure Gage

Provide a shut-off valve or pet cock between pressure gages and the line.

3.2.11 Thermometers

Provide thermometers and thermal sensing elements of control valves with a separable socket. Install separable sockets in pipe lines in such a manner to sense the temperature of flowing the fluid and minimize obstruction to flow.

3.2.12 Strainers

Provide strainers, with meshes suitable for the services, where indicated, or where dirt might interfere with the proper operation of valve parts, orifices, or moving parts of equipment.

3.2.13 Pumps

Select pumps for specified fluid temperatures, are non-overloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve. Support piping adjacent to pump such that no weight is carried on pump casings. Install close coupled and base mounted pumps on concrete base, with anchor bolts, set and level, and grout in place and provide supports under elbows on pump suction and discharge line sizes 4 inches and over. Lubricate pump before start-up.

3.2.14 Equipment Foundations

Locate equipment foundations as shown on the drawings. Size, weight, and design shall preclude shifting of equipment under operating conditions. Foundations shall meet the requirements of the equipment manufacturer. Concrete shall conform to Section 03 30 00 CAST-IN-PLACE CONCRETE, and grout shall be approved non-shrinking.

3.2.15 Equipment Installation

Install equipment in accordance with installation instructions of the manufacturers. Grout equipment mounted on concrete foundations before installing piping. Install piping in such a manner as not to place a strain on the equipment. Do not bolt flanged joints tight unless they match. Grade, anchor, guide, and support piping without low pockets.

3.2.16 Cleaning of Systems

As installation of the various system components is completed, fill, start, and vent prior to cleaning. Place terminal control valves in open position. Add cleaner to closed system at concentration as recommended by manufacturer. Apply heat while circulating, slowly raising temperature to

160 degrees F and maintain for 12 hours minimum. Remove heat and circulate to 100 degrees F or less; drain systems as quickly as possible and refill with clean water. Circulate for 6 hours at design temperatures, then drain. Refill with clean water and repeat until system cleaner is removed. Use neutralizer agents on recommendation of system cleaner supplier and approval of Contracting Officer. Remove, clean, and replace strainer screens. Inspect, remove sludge, and flush low points with clean water after cleaning process is completed. Include disassembly of components as required. Preliminary or final tests are not permitted until cleaning is approved.

3.2.17 Painting of Piping and Equipment

Provide in accordance with Section 09 90 00 PAINTS AND COATINGS.

3.2.18 Identification of Piping

Identify piping in accordance with OSHA 29 CFR 1910.144, except that labels or tapes may be used in lieu of painting or stenciling. Spacing of identification marking on runs shall not exceed 50 feet. Materials for labels and tapes shall conform to CID A-A-1689, and shall be general purpose type and color class. Painting and stenciling shall conform to Section 09 90 00 PAINTS AND COATINGS.

3.3 FIELD QUALITY CONTROL

Perform inspections and tests as specified herein to demonstrate that piping and equipment, as installed, is in compliance with contract requirements. Start up and operate the system. During this time, periodically clean the various strainers until no further accumulation of foreign material occurs. Exercise care so that minimum loss of water occurs when strainers are cleaned. Adjust safety and automatic control instruments to place them in proper operation and sequence.

3.3.1 Hydrostatic Test of Piping System

Test piping system hydrostatically using water not exceeding 100 degrees F. Conduct tests in accordance with the requirements of ASME B31.9 and as follows. Test piping system after all lines have been cleaned and before applying insulation covering. Remove or valve off from the system, gages, and other apparatus which may be damaged by the test before the tests are made. Install calibrated test pressure gage in the system to observe any loss in pressure. Maintain test pressure for a sufficient length of time to enable an inspection of each joint and connection. Perform tests after installation and prior to acceptance. Notify the Contracting Officer in writing 45 days prior to the time scheduled for the tests.

3.3.2 Auxiliary Equipment and Accessory Tests

Observe and check pumps, accessories, and equipment during operational and capacity tests for leakage, malfunctions, defects, noncompliance with referenced standards, or overloading.

3.3.2.1 Backflow Preventers

Backflow preventers shall be tested by locally approved and certified backflow assembly testers. A copy of the test report shall be provided to the Contracting Officer prior to placing the domestic water system into operation, or no later than 5 days after the test.

3.4 TESTING, ADJUSTING, AND BALANCING

Test, adjust, and balance the hydronic system in accordance with Section
23 05 93 TESTING, ADJUSTING AND BALANCING FOR HVAC.

3.4.1 Markings of Settings

Following final acceptance of the balancing report, the settings of all valves, splitters, dampers, and other adjustment devices shall be permanently marked so that adjustment can be restored if disturbed at anytime.

-- End of Section --

SECTION 23 21 23

HYDRONIC PUMPS
08/17

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.1 (2003; R 2018) Unified Inch Screw Threads
(UN and UNR Thread Form)

ASME B16.1 (2020) Gray Iron Pipe Flanges and Flanged
Fittings Classes 25, 125, and 250

ASTM INTERNATIONAL (ASTM)

ASTM A48/A48M (2003; R 2021) Standard Specification for
Gray Iron Castings

ASTM A123/A123M (2017) Standard Specification for Zinc
(Hot-Dip Galvanized) Coatings on Iron and
Steel Products

ASTM A153/A153M (2016a) Standard Specification for Zinc
Coating (Hot-Dip) on Iron and Steel
Hardware

ASTM A307 (2021) Standard Specification for Carbon
Steel Bolts, Studs, and Threaded Rod 60
000 PSI Tensile Strength

HYDRAULIC INSTITUTE (HI)

HI 1.1-1.2 (2014) Rotodynamic (Centrifugal) Pump for
Nomenclature and Definitions

HI 1.3 (2013) Rotodynamic (Centrifugal) Pump
Applications

HI 9.6.4 (2009) Rotodynamic Pumps for Vibration
Analysis and Allowable Values

HI ANSI/HI 2.1-2.2 (2014) Rotodynamic Vertical Pumps of
Radial, Mixed, and Axial Flow Types for
Nomenclature and Definitions

HI ANSI/HI 9.6.3 (2017) Rotodynamic Pumps - Guideline for
Operating Regions - B120

HI ANSI/HI 14.6 (2011) Rotodynamic Pumps for Hydraulic
Performance Acceptance Tests - A136

INTERNATIONAL CODE COUNCIL (ICC)

ICC IgCC (2018) International Green Construction Code

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1 (2021) Motors and Generators

NEMA Z535.4 (2011; R 2017) Product Safety Signs and Labels

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC Paint 21 (1982; E 2004) White or Colored Silicone Alkyd Paint (Type I, High Gloss and Type II, Medium Gloss)

SSPC Paint 25 (1997; E 2004) Zinc Oxide, Alkyd, Linseed Oil Primer for Use Over Hand Cleaned Steel, Type I and Type II

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.219 Mechanical Power Transmission Apparatus

UNDERWRITERS LABORATORIES (UL)

UL 778 (2016; Reprint Jun 2021) UL Standard for Safety Motor-Operated Water Pumps

1.2 SUBMITTALS

Government approval is required for submittals. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

System Coordination;

SD-03 Product Data

Instructions;

Equipment Data;

Training Period;

SD-06 Test Reports

Factory Tests

Field Quality Control

SD-07 Certificates

Manufacturer's Representative

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals;

Training; G

1.3 QUALITY ASSURANCE

1.3.1 Manufacturer Services

Provide the services of a [manufacturer's representative](#) experienced in the installation, adjustment, and operation of the equipment specified. The representative must supervise the installation, adjustment, testing of the equipment, and conduct training.

Submit the names and qualifications of the manufacturer's representative and training engineers and written certification from the manufacturer that the representative and trainers are technically qualified.

1.3.2 Standard Products

Provide material and equipment which are the standard products of a manufacturer regularly engaged in the manufacture of such products and that essentially duplicate equipment that has been in satisfactory HVAC operation at least 2 years prior to issuance of this solicitation. Support equipment with a service organization that is reasonably convenient to the jobsite. Pumps and motors of the same types must each be the product of one manufacturer.

1.3.3 Conformance with Agency Requirements

Where materials or equipment are specified to be an approved type, attach the seal or label of approval from a nationally recognized testing agency, adequately equipped and competent to perform such services. A written certificate from the testing agency must accompany the materials or equipment and be submitted stating that the items have been tested and that they conform to the applicable requirements of the specifications and to the standards listed herein. The certificate must indicate the methods of testing used by the testing agency. In lieu of a certificate from a testing agency, published catalog specification data, accompanied by the manufacturer's certified statement to the effect that the items are in accordance with the applicable requirements of the specifications and the referenced standards, will be considered and may be acceptable as evidence that the items conform with agency requirements.

1.4 DELIVERY, STORAGE, AND HANDLING

Protect equipment, delivered and designated for storage, from the weather, humidity and temperature variations, dirt and dust, or other contaminants.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

Hydronic pumps used for heating and air conditioning applications are defined by the type of impeller, number of impellers, type of casing, method of connection to the driver, and mounting position. Provide centrifugal water pumps of the types indicated and specified. Use an electric motor driving unit for each pump as indicated and specified.

2.1.1 Selection Criteria

Select pumps at a point within the maximum efficiency for a given impeller casing combination. Deviations within 3 percent of maximum efficiency are permissible, provided the lesser efficiency is not less than the scheduled efficiency in the construction design documents. Pumps having impeller diameters larger or smaller than manufacturer's published maximum and minimum impeller diameters for a given impeller casing combination will be rejected. Pump performance data, as shown in performance curves, must be based on factory tests using precision instrumentation and exacting procedures as detailed in [HI ANSI/HI 14.6](#).

2.1.2 System Coordination

Submit drawings containing complete wiring and piping schematic diagrams and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Show the proposed layout and anchorage of equipment and appurtenances, and equipment relationship to other parts of the work including clearances for maintenance and operation. Provide a complete listing of equipment, materials and miscellaneous components including mechanical seals, bearings, and couplings.

2.1.3 Safety Requirements

Fully enclose or guard couplings, projecting set-screws, keys, and other rotating parts, that pose an entangling hazards..

2.2 MATERIALS AND EQUIPMENT

2.2.1 Nameplates

Securely affix a standard nameplate to pumps and motors in a conspicuous place showing the manufacturer's name, address, type or style, model, serial number, and catalog number. In addition, for each pump show the capacity in [gpm](#) at rated speed in rpm and total head in [feet](#) of water. For each electric motor show at least the minimum information required by [NEMA MG 1](#). Show such other information as the manufacturer may consider necessary to complete identification on the nameplate. Pumps must be listed and labeled by UL, and comply with [UL 778](#) for pumps not using universal motors rated more than 250 volts such as circulating pumps.

2.2.2 Framed Instructions

Submit proposed diagrams, instructions, and other sheets, prior to posting. Post approved wiring and control diagrams showing the complete layout of the entire system, including equipment, piping valves, and control sequence, framed under glass or in approved laminated plastic, where directed. Provide condensed operating instructions explaining preventive maintenance procedures, methods of checking the system for normal safe operation, and procedures for safely starting and stopping the system, framed as specified above for the wiring and control diagrams, and posted beside the diagrams. Post the framed instructions before acceptance testing of the systems.

2.2.3 Pump Characteristic

Construct hydronic water pumps in accordance with [HI 1.1-1.2](#) and

HI ANSI/HI 2.1-2.2. The pumps must be capable of discharging quantities at total discharge heads measured at the discharge flange, between the following limits:

Operate pumps at optimum efficiencies to produce the most economical pumping system under the conditions encountered and size to make optimum match with the system head curve as shown. Pumps must furnish not less than 150 percent of rated capacity at a total discharge head of not less than 65 percent of total rated head. The shutoff total head must not be greater than 120 percent of total rated head. Operate pumps at specified system fluid temperatures without vapor binding and cavitation. Operate pumps to HI ANSI/HI 9.6.3 standard for Preferred Operating Region (POR).

2.2.4 Pump Drivers

Provide electric motors as indicated for each pump and in compliance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM .

2.2.5 Equipment Data

Submit manufacturer's descriptive data and technical literature, performance charts and curves for all impeller sizes for a given casing, catalog cuts, and installation instructions. Provide spare parts data for each different item of material and equipment specified, after approval of the detail drawings and not later than 2 months prior to the date of beneficial occupancy. Include a complete list of parts and supplies, with current unit prices and local source of supply with contact information.

Submit catalog information, certified pumps curves, rated capacities, final impeller dimensions, and accessories provided for the product indicated. Indicate operating point of each pump on curves. Furnish pump curves for each pump and combination of pumps designed to operate in parallel. The pump curve must show as a minimum; bhp, flow, total dynamic head, efficiency, NPSH, impeller diameter and system curve (individually and in combination for each pump operating in a parallel application). Select pumps operating in parallel operation to cross the system curve when operating individually.

2.3 HYDRONIC PUMPS

Provide centrifugal, single-stage type, designed for HVAC service as indicated on the drawings:

2.3.1 Small In-Line

Provide pumps with capacities as indicated, suitable for 225 degrees F operation at 175 psig working pressure. The pump must be single stage, in-line design, in cast iron bronze fitted construction. The pump internals must be capable of being serviced without disturbing piping connections.

2.3.1.1 Pump Shaft

The pump must have a solid steel shaft with a coupler between the pump and motor shafts. For non-stainless steel shafts, employ a non-ferrous shaft sleeve to completely cover the wetted area under the seal.

2.3.1.2 Bearing

The bearing assembly must house maintenance-free permanently lubricated bearings.

2.3.1.3 Seal Assembly

Equip the pump with an internal self-flushing mechanical seal assembly. Seal assembly must have Buna bellows and seat gasket, stainless steel spring, and be of a carbon ceramic design with the carbon face rotating against a stationary ceramic face.

2.3.1.4 Impeller

Provide impeller of cast bronze or brass material. Impeller must be hydraulically and dynamically balanced to **HI 9.6.4** balance grade G6.3, keyed to the shaft and secured by a locking capscrew or nut.

2.3.1.5 Volute

Pump volute must be of cast iron. The connection style on cast iron pumps must be flanged.

2.3.1.6 Motor Mount

To ensure alignment, mount the motor to the bearing assembly via a bolted motor bracket assembly. Use a replaceable resilient rubber motor mount to assist in aligning the motor shaft with the pump shaft.

2.3.1.7 Motors

NEMA MG 1; premium efficiency; non-overloading at any point on the pump curve; maintenance free with permanently lubricated bearings; and resilient mounted for smaller sizes, rigid mounted otherwise.

2.3.2 Large In-Line

Provide pumps with capacities as indicated; in-line, single stage, for installation in vertical position, and suitable for **225 degrees F** operation at **175 psig** working pressure. The pump internals must be capable of being serviced without disturbing piping connections.

2.3.2.1 Casing

Provide pump casing complying with **ASTM A48/A48M** Class 30 cast iron, suitable for **175 psig** working pressure with integral cast iron flanges drilled for **ASME B16.1** ANSI Class 250 flanges, with an integrally-cast support ring matching an Class 125 flange for pump support. The pump volute must include gauge tappings at suction and discharge nozzles along with vent and drain tappings at top and bottom.

2.3.2.2 Pump Shaft

Provide carbon or stainless steel pump shaft, guided by a carbon graphite lower throttle bushing. Carbon steel pump shaft must have a bronze shaft sleeve that completely covers the wetted area under the seal.

2.3.2.3 Seal Assembly

Equip the pump with a mechanical seal assembly consisting of a carbon seal rotating ring, stainless steel spring, ceramic seat and flexible bellows and gasket. The liquid cavity must have a tapped flush line with manual valve to remove air from the seal chamber to allow fast initial start-up and insure mechanical seal cooling.

2.3.2.4 Spacer Coupling

The axially split spacer coupling must be of high tensile aluminum, split to allow the servicing of the seal without disturbing the pump or motor. Pump coupler must be aligned by the manufacturer before shipment. The motor bracket must contain a carbon steel coupler guard conforming to 29 CFR 1910.219 standards for safety.

2.3.2.5 Impeller

Hydraulically and dynamically balance the impeller to HI 9.6.4 balance grade G6.3, closed, single suction, fabricated from cast bronze, keyed to the shaft and secured by a locking capscrew.

2.3.2.6 Motor

Electric motors must meet NEMA MG 1 and the horsepower, speed, voltage, indicated. Motor enclosure must be open drip proof, totally enclosed fan cooled, with heavy duty grease lubricated ball bearings completely adequate for the maximum load for which the motor is designed. Motor must be non-overloading at any point on the pump curve and premium efficiency. Provide motor efficiencies as shown in the ICC IgCC standard. Totally enclosed fan cooled motor efficiencies must be as shown in NEMA MG 1.

Include one-piece combination motor bracket and volute coverplate in the assembly to ensure concentric alignment of the motor to the pump casing.

2.4 EQUIPMENT APPURTENANCES

2.4.1 Attachments

Furnish all necessary bolts, nuts, washers, bolt sleeves, and other types of attachments with the equipment for the installation of the equipment. Bolts conform to the requirements of ASTM A307 and hexagonal nuts of the same quality as the bolts used. Threads must be clean-cut and conform to ASME B1.1. Bolts, nuts, and washers specified to be galvanized or not otherwise indicated or specified, must be zinc coated after being threaded, by the hot-dip process conforming to ASTM A123/A123M or ASTM A153/A153M as appropriate. Bolts, nuts, and washers specified or indicated to be stainless steel must be Type 316.

2.4.2 Equipment Guards

Provide equipment driven by open shafts, belts, chains, or gears with all-metal guards enclosing the drive mechanism. Secure guards in position with steel braces or straps that permit easy removal for servicing the equipment. Coupler guards must comply with current national safety standards including 29 CFR 1910.219 and NEMA Z535.4. Provide guards with gaps no greater than 0.250 inches, safety orange in color, and have an NEMA Z535.4 compliant warning label.

2.4.3 Tools

Furnish a complete set of all special tools which may be necessary for the adjustment, operation, maintenance, and disassembly of all equipment. Special tools are considered to be those tools which because of their limited use are not normally available, but which are necessary for the particular equipment. Special tools must be high-grade, smooth, forged, alloy, tool steel. Furnish one pressure grease gun for each type of grease required. Deliver all tools at the same time as the equipment to which they pertain. Properly store and safeguard such tools until completion of the work, at which time deliver them to the Contracting Officer.

2.5 FINISHES

All motors, pump casings, and similar parts of equipment must be thoroughly cleaned, primed, and given two finish coats of paint at the factory in accordance with the recommendations of the manufacturer. Give ferrous surfaces not to be painted a shop coat of grease or other suitable rust-resistant coating.

2.6 FACTORY TESTS

Pumps must be tested by the manufacturer or a nationally recognized testing agency in compliance with HI 1.3. Submit certified test results.

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with all details of the work, verify all dimensions in the field and advise the Contracting Officer of any discrepancy before performing the work.

3.2 INSTALLATION

Install each pump and motor in accordance with the written instructions of the manufacturer. Provide access space around the device for servicing no less than the minimum recommended by the manufacturer.

3.3 FIELD QUALITY CONTROL

After installation of the pumping units and appurtenances, including coupling guard, is complete, carry out operating tests to assure that the pumping installation operates properly. Make arrangements to have the manufacturer's representatives present when field equipment tests are made.

Give each pumping unit a running field test in the presence of the Contracting Officer for a minimum of 2 hours. Operate each pumping unit at its rated capacity or such other point on its head-capacity curve selected by the Contracting Officer. Provide an accurate and acceptable method of measuring the discharge flow. Tests must assure that the units and appurtenances have been installed correctly, that there is no objectionable heating, vibration, or noise from any parts, and that all manual and automatic controls function properly. If any deficiencies are revealed during any tests, correct such deficiencies and reconduct the tests.

Submit test reports in booklet form showing all field tests performed to adjust each component and all field tests performed to prove compliance

with the specified performance criteria, upon completion and testing of the installed system. Each test report must indicate the final position of controls.

3.4 FIELD PAINTING

Do not paint stainless steel, galvanized steel, and nonferrous surfaces.

3.4.1 Touch-up painting

Factory painted items requiring touching up in the field must be thoroughly cleaned of all foreign material, and primed and topcoated with the manufacturer's standard factory finish.

3.4.2 Exposed Ferrous Surfaces

Paint exposed ferrous surfaces with two coats of enamel paint conforming to **SSPC Paint 21**. Solvent clean factory primed surfaces before painting. Surfaces that have not been factory primed must be prepared and primed with one coat of **SSPC Paint 25** or in accordance with the enamel paint manufacturer's recommendations.

3.5 CLOSEOUT ACTIVITIES

3.5.1 **Operation and Maintenance Manuals**

Submit one complete set at the time the tests procedure is submitted; remaining sets before the contract is completed. Permanently bind each in a hard cover. Inscribe the following identification on the covers: the words "OPERATING AND MAINTENANCE INSTRUCTIONS," name and location of the building, name of the Contractor, and contract number. Place flysheets before instructions covering each subject. Use **8-1/2 by 11 inches** paper for instruction sheets, with large sheets of drawings folded in.

Include, but do not limit to, the following in the Instructions:

- a. System layout showing piping, valves, and controls.
- b. Approved wiring and control diagrams including variable frequency drives.
- c. A control sequence describing startup, operation, and shutdown.
- d. Operating and maintenance instructions for each piece of equipment, including task list for routine maintenance, routine inspections, intermediate inspections, and annual inspections; lubrication instructions; and troubleshooting guide.
- e. Manufacturer's bulletins, cuts, and descriptive data; and parts list and recommended spare parts.

3.5.2 **Training**

Upon completion of the work, and at a time designated by the Contracting Officer, provide the services of one or more competent engineers for a **training period** of not less than **8** hours to instruct a representative of the Government in the contents of the operation and maintenance manuals for the equipment furnished under these specifications. These field instructions must cover all the items contained in the bound

instructions. Submit the training course curriculum and training instructions 14 days prior to the start of training.

-- End of Section --

SECTION 23 30 00

HVAC AIR DISTRIBUTION
05/20, CHG 1: 02/22

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AIR CONDITIONING CONTRACTORS OF AMERICA (ACCA)

ACCA Manual 4 (2001) Installation Techniques for
Perimeter Heating and Cooling; 11th Edition

AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL, INC. (AMCA)

AMCA 201 (2002; R 2011) Fans and Systems

AMCA 210 (2016) Laboratory Methods of Testing Fans
for Aerodynamic Performance Rating

AMCA 300 (2014) Reverberant Room Method for Sound
Testing of Fans

AMCA 301 (2014) Methods for Calculating Fan Sound
Ratings from Laboratory Test Data

AMCA 500-D (2018) Laboratory Methods of Testing
Dampers for Rating

AIR-CONDITIONING, HEATING AND REFRIGERATION INSTITUTE (AHRI)

AHRI 260 I-P (2012) Sound Rating of Ducted Air Moving
and Conditioning Equipment

AHRI 410 (2001; Addendum 1 2002; Addendum 2 2005;
Addendum 3 2011) Forced-Circulation
Air-Cooling and Air-Heating Coils

AHRI 430 (2009) Central-Station Air-Handling Units

AHRI 880 I-P (2011) Performance Rating of Air Terminals

AHRI 885 (2008; Addendum 2011) Procedure for
Estimating Occupied Space Sound Levels in
the Application of Air Terminals and Air
Outlets

AHRI Guideline D (1996) Application and Installation of
Central Station Air-Handling Units

AMERICAN BEARING MANUFACTURERS ASSOCIATION (ABMA)

ABMA 9 (2015) Load Ratings and Fatigue Life for

Ball Bearings

ABMA 11 (2014) Load Ratings and Fatigue Life for
Roller Bearings

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING
ENGINEERS (ASHRAE)

ASHRAE 52.2 (2012) Method of Testing General
Ventilation Air-Cleaning Devices for
Removal Efficiency by Particle Size

ASHRAE 62.1 (2016) Ventilation for Acceptable Indoor
Air Quality

ASHRAE 68 (1997) Laboratory Method of Testing to
Determine the Sound Power In a Duct

ASHRAE 70 (2006; R 2021) Method of Testing the
Performance of Air Outlets and Inlets

ASHRAE 90.1 - IP (2019; Errata 1 2019; Errata 2-5 2020;
Addenda BY-CP 2020; Addenda AF-DB 2020;
Addenda A-G 2020; Addenda F-Y 2021;
Errata 6-8 2021; Interpretation 1-4 2020;
Interpretation 5-8 2021 Addenda AS-AQ
2022) Energy Standard for Buildings Except
Low-Rise Residential Buildings

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME A13.1 (2020) Scheme for the Identification of
Piping Systems

ASTM INTERNATIONAL (ASTM)

ASTM A53/A53M (2022) Standard Specification for Pipe,
Steel, Black and Hot-Dipped, Zinc-Coated,
Welded and Seamless

ASTM A123/A123M (2017) Standard Specification for Zinc
(Hot-Dip Galvanized) Coatings on Iron and
Steel Products

ASTM A167 (2011) Standard Specification for
Stainless and Heat-Resisting
Chromium-Nickel Steel Plate, Sheet, and
Strip

ASTM B152/B152M (2019) Standard Specification for Copper
Sheet, Strip, Plate, and Rolled Bar

ASTM B209 (2014) Standard Specification for Aluminum
and Aluminum-Alloy Sheet and Plate

ASTM B280 (2020) Standard Specification for Seamless
Copper Tube for Air Conditioning and
Refrigeration Field Service

ASTM B766	(1986; R 2015) Standard Specification for Electrodeposited Coatings of Cadmium
ASTM C553	(2013; R 2019) Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications
ASTM C916	(2020) Standard Specification for Adhesives for Duct Thermal Insulation
ASTM C1071	(2019) Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material)
ASTM E84	(2020) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM E2016	(2022) Standard Specification for Industrial Woven Wire Cloth

CALIFORNIA DEPARTMENT OF PUBLIC HEALTH (CDPH)

CDPH SECTION 01350	(2010; Version 1.1) Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources using Environmental Chambers

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(2021) Motors and Generators
NEMA MG 10	(2017) Energy Management Guide for Selection and Use of Fixed Frequency Medium AC Squirrel-Cage Polyphase Induction Motors
NEMA MG 11	(1977; R 2012) Energy Management Guide for Selection and Use of Single Phase Motors

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 90A	(2021) Standard for the Installation of Air Conditioning and Ventilating Systems
NFPA 96	(2021) Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations
NFPA 701	(2019) Standard Methods of Fire Tests for Flame Propagation of Textiles and Films

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA 1819	(2002) Fire, Smoke and Radiation Damper Installation Guide for HVAC Systems, 5th Edition

SMACNA 1966	(2020) HVAC Duct Construction Standards Metal and Flexible, 4th Edition
SMACNA 1972 CD	(2012) HVAC Air Duct Leakage Test Manual - 2nd Edition
SMACNA 1981	(2008) Seismic Restraint Manual Guidelines for Mechanical Systems, 3rd Edition
SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT (SCAQMD)	
SCAQMD Rule 1168	(2017) Adhesive and Sealant Applications
U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)	
40 CFR 82	Protection of Stratospheric Ozone
UNDERWRITERS LABORATORIES (UL)	
UL 6	(2022) UL Standard for Safety Electrical Rigid Metal Conduit-Steel
UL 181	(2013; Reprint Dec 2021) UL Standard for Safety Factory-Made Air Ducts and Air Connectors
UL 555	(2006; Reprint Aug 2016) UL Standard for Safety Fire Dampers
UL 586	(2009; Reprint Sep 2022) UL Standard for Safety High-Efficiency Particulate, Air Filter Units
UL 705	(2017; Reprint Aug 2022) UL Standard for Safety Power Ventilators
UL 723	(2018) UL Standard for Safety Test for Surface Burning Characteristics of Building Materials
UL 900	(2015; Reprint Aug 2022) UL Standard for Safety Standard for Air Filter Units
UL 1995	(2015; Reprint Aug 2022) UL Standard for Safety Heating and Cooling Equipment
UL Bld Mat Dir	(updated continuously online) Building Materials Directory
UL Electrical Construction	(2012) Electrical Construction Equipment Directory
UL Fire Resistance	(2014) Fire Resistance Directory

1.2 SYSTEM DESCRIPTION

Furnish ductwork, piping offsets, fittings, and accessories as required to provide a complete installation. Coordinate the work of the different trades to avoid interference between piping, equipment, structural, and

electrical work. Provide complete, in place, all necessary offsets in piping and ductwork, and all fittings, and other components, required to install the work as indicated and specified.

1.2.1 Mechanical Equipment Identification

The number of charts and diagrams must be equal to or greater than the number of mechanical equipment rooms. Where more than one chart or diagram per space is required, mount these in edge pivoted, swinging leaf, extruded aluminum frame holders which open to 170 degrees.

1.2.1.1 Charts

Provide chart listing of equipment by designation numbers and capacities such as flow rates, pressure and temperature differences, heating and cooling capacities, horsepower, pipe sizes, and voltage and current characteristics.

1.2.2 Service Labeling

Label equipment, including fans, air handlers, terminal units, etc. with labels made of self-sticking, plastic film designed for permanent installation. Provide labels in accordance with the typical examples below:

SERVICE	LABEL AND TAG DESIGNATION
Air handling unit Number	AHU -
Control and instrument air	CONTROL AND INSTR.
Exhaust Fan Number	EF -
VAV Box Number	VAV -
Fan Coil Unit Number	FC -
Terminal Box Number	TB -
Unit Ventilator Number	UV -

Identify similar services with different temperatures or pressures. Where pressures could exceed **125 pounds per square inch, gage**, include the maximum system pressure in the label. Label and arrow piping in accordance with the following:

- Each point of entry and exit of pipe passing through walls.
- Each change in direction, i.e., elbows, tees.
- In congested or hidden areas and at all access panels at each point required to clarify service or indicated hazard.
- In long straight runs, locate labels at distances within eyesight of each other not to exceed **75 feet**. All labels must be visible and

legible from the primary service and operating area.

For Bare or Insulated Pipes	
for Outside Diameters of	Lettering
1/2 thru 1-3/8 inch	1/2 inch
1-1/2 thru 2-3/8 inch	3/4 inch
2-1/2 inch and larger	1-1/4 inch

1.2.3 Color Coding

Color coding of all piping systems must be in accordance with [ASME A13.1](#) .

1.3 SUBMITTALS

Government approval is required for submittals. Submit the following in accordance with Section [01 33 00](#) SUBMITTAL PROCEDURES:

[SD-02 Shop Drawings](#)

[Detail Drawings;](#)

[SD-03 Product Data](#)

[Metallic Flexible Duct](#)

[Insulated Nonmetallic Flexible Duct Runouts](#)

[Duct Connectors](#)

[Duct Access Doors;](#)

[Fire Dampers](#)

[Manual Balancing Dampers;](#)

[Sound Attenuation Equipment](#)

[Acoustical Duct Liner](#)

[Diffusers](#)

[Registers and Grilles](#)

[Louvers](#)

[Air Vents, Penthouses, and Goosenecks](#)

[Centrifugal Fans](#)

[Centrifugal Type Power Roof Ventilators](#)

[Air-Curtain Fans](#)

[Air Handling Units; G](#)

Constant Volume, Single Duct Terminal Units;

Variable Volume, Single Duct Terminal Units;

Reheat Units;

Test Procedures

Indoor Air Quality for Duct Sealants;

SD-06 Test Reports

Performance Tests;

Damper Acceptance Test;

SD-07 Certificates

Ozone Depleting Substances Technician Certification

SD-08 Manufacturer's Instructions

Manufacturer's Installation Instructions

Operation and Maintenance Training

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals;

Fire Dampers; G

Manual Balancing Dampers;

Centrifugal Fans; G

Centrifugal Type Power Roof Ventilators;

Air-Curtain Fans;

Air Handling Units;

Constant Volume, Single Duct Terminal Units;

Variable Volume, Single Duct Terminal Units;

Reheat Units;

SD-11 Closeout Submittals

Indoor Air Quality During Construction;

1.4 QUALITY ASSURANCE

Except as otherwise specified, approval of materials and equipment is based on manufacturer's published data.

- a. Where materials and equipment are specified to conform to the

standards of the Underwriters Laboratories, the label of or listing with reexamination in **UL Bld Mat Dir**, and **UL 6** is acceptable as sufficient evidence that the items conform to Underwriters Laboratories requirements. In lieu of such label or listing, submit a written certificate from any nationally recognized testing agency, adequately equipped and competent to perform such services, stating that the items have been tested and that the units conform to the specified requirements. Outline methods of testing used by the specified agencies.

- b. Where materials or equipment are specified to be constructed or tested, or both, in accordance with the standards of the ASTM International (ASTM), the ASME International (ASME), or other standards, a manufacturer's certificate of compliance of each item is acceptable as proof of compliance.
- c. Conformance to such agency requirements does not relieve the item from compliance with other requirements of these specifications.
- d. Where products are specified to meet or exceed the specified energy efficiency requirement of FEMP-designated or ENERGY STAR covered product categories, equipment selected must have as a minimum the efficiency rating identified under "Energy-Efficient Products" at <http://femp.energy.gov/procurement>.

1.4.1 Prevention of Corrosion

Protect metallic materials against corrosion. Provide rust-inhibiting treatment and standard finish for the equipment enclosures. Do not use aluminum in contact with earth, and where connected to dissimilar metal. Protect aluminum by approved fittings, barrier material, or treatment. Provide hot-dip galvanized ferrous parts such as anchors, bolts, braces, boxes, bodies, clamps, fittings, guards, nuts, pins, rods, shims, thimbles, washers, and miscellaneous parts not of corrosion-resistant steel or nonferrous materials in accordance with **ASTM A123/A123M** for exterior locations and cadmium-plated in conformance with **ASTM B766** for interior locations.

1.4.2 Asbestos Prohibition

Do not use asbestos and asbestos-containing products.

1.4.3 Ozone Depleting Substances Technician Certification

All technicians working on equipment that contain ozone depleting refrigerants must be certified as a Section 608 Technician to meet requirements in **40 CFR 82**, Subpart F. Provide copies of technician certifications to the Contracting Officer at least 14 calendar days prior to work on any equipment containing these refrigerants.

1.4.4 Detail Drawings

Submit detail drawings showing equipment layout, including assembly and installation details and electrical connection diagrams; ductwork layout showing the location of all supports and hangers, typical hanger details, gauge reinforcement, reinforcement spacing rigidity classification, and static pressure and seal classifications. Include any information required to demonstrate that the system has been coordinated and functions properly as a unit on the drawings and show equipment relationship to

other parts of the work, including clearances required for operation and maintenance. Submit drawings showing bolt-setting information, and foundation bolts prior to concrete foundation construction for all equipment indicated or required to have concrete foundations. Submit function designation of the equipment and any other requirements specified throughout this Section with the shop drawings.

1.4.5 Test Procedures

Conduct performance tests as required in Section 23 05 93 Testing, Adjusting and Balancing for HVAC and Section 23 09 00 Instrumentation and Control for HVAC.

1.5 DELIVERY, STORAGE, AND HANDLING

Protect stored equipment at the jobsite from the weather, humidity and temperature variations, dirt and dust, or other contaminants. Additionally, cap or plug all pipes until installed.

PART 2 PRODUCTS

2.1 STANDARD PRODUCTS

Provide components and equipment that are "standard products" of a manufacturer regularly engaged in the manufacturing of products that are of a similar material, design and workmanship. "Standard products" is defined as being in satisfactory commercial or industrial use for 2 years before bid opening, including applications of components and equipment under similar circumstances and of similar size, satisfactorily completed by a product that is sold on the commercial market through advertisements, manufacturers' catalogs, or brochures. Products having less than a 2-year field service record are acceptable if a certified record of satisfactory field operation, for not less than 6000 hours exclusive of the manufacturer's factory tests, can be shown. Provide equipment items that are supported by a service organization. In product categories covered by ENERGY STAR or the Federal Energy Management Program, provide equipment that is listed on the ENERGY STAR Qualified Products List or that meets or exceeds the FEMP-designated Efficiency Requirements.

2.2 IDENTIFICATION PLATES

In addition to standard manufacturer's identification plates, provide engraved laminated phenolic identification plates for each piece of mechanical equipment. Identification plates are to designate the function of the equipment. Submit designation with the shop drawings. Provide identification plates that are layers, black-white-black, engraved to show white letters on black background. Letters must be upper case. Identification plates that are 1-1/2-inches high and smaller must be 1/16-inch thick, with engraved lettering 1/8-inch high; identification plates larger than 1-1/2-inches high must be 1/8-inch thick, with engraved lettering of suitable height. Identification plates 1-1/2-inches high and larger must have beveled edges. Install identification plates using a compatible adhesive.

2.3 EQUIPMENT GUARDS AND ACCESS

Fully enclose or guard belts, pulleys, chains, gears, couplings, projecting setscrews, keys, and other rotating parts exposed to personnel contact according to OSHA requirements. Properly guard or cover with

insulation of a type specified, high temperature equipment and piping exposed to contact by personnel or where it creates a potential fire hazard. The requirements for catwalks, operating platforms, ladders, and guardrails are specified in Section 08 31 00 ACCESS DOORS AND PANELS.

2.4 ELECTRICAL WORK

- a. Provide motors, controllers, integral disconnects, contactors, and controls with their respective pieces of equipment, except controllers indicated as part of motor control centers. Provide electrical equipment, including motors and wiring, as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Provide manual or automatic control and protective or signal devices required for the operation specified and control wiring required for controls and devices specified, but not shown. For packaged equipment, include manufacturer provided controllers with the required monitors and timed restart.
- b. For single-phase motors, provide high-efficiency type, fractional-horsepower alternating-current motors, including motors that are part of a system, in accordance with NEMA MG 11. Provide premium efficiency type integral size motors in accordance with NEMA MG 1.
- c. For polyphase motors, provide squirrel-cage medium induction motors, including motors that are part of a system, and that meet the efficiency ratings for premium efficiency motors in accordance with NEMA MG 1. Select premium efficiency polyphase motors in accordance with NEMA MG 10.
- d. Provide motors in accordance with NEMA MG 1 and of sufficient size to drive the load at the specified capacity without exceeding the nameplate rating of the motor. Provide motors rated for continuous duty with the enclosure specified. Provide motor duty that allows for maximum frequency start-stop operation and minimum encountered interval between start and stop. Provide motor torque capable of accelerating the connected load within 20 seconds with 80 percent of the rated voltage maintained at motor terminals during one starting period. Provide motor starters complete with thermal overload protection and other necessary appurtenances. Fit motor bearings with grease supply fittings and grease relief to outside of the enclosure.
- e. Where two-speed or variable-speed motors are indicated, solid-state variable-speed controllers are allowed to accomplish the same function. Use solid-state variable-speed controllers for motors rated 10 hp or less and adjustable frequency drives for larger motors. Provide variable frequency drives for motors as specified in Section 26 29 23 ADJUSTABLE SPEED DRIVE SYSTEMS UNDER 600 VOLTS.

2.5 ANCHOR BOLTS

Provide anchor bolts for equipment placed on concrete equipment pads or on concrete slabs. Bolts to be of the size and number recommended by the equipment manufacturer and located by means of suitable templates. Installation of anchor bolts must not degrade the surrounding concrete.

2.6 SEISMIC ANCHORAGE

Anchor equipment in accordance with applicable seismic criteria for the

area and as defined in [SMACNA 1981](#)

2.7 PAINTING

Paint equipment units in accordance with approved equipment manufacturer's standards unless specified otherwise. Field retouch only if approved. Otherwise, return equipment to the factory for refinishing. Paint in accordance with Section [09 96 00](#) HIGH-PERFORMANCE COATINGS.

2.8 INDOOR AIR QUALITY

Provide equipment and components that comply with the requirements of [ASHRAE 62.1](#) unless more stringent requirements are specified herein.

2.9 DUCT SYSTEMS

2.9.1 Metal Ductwork

Provide metal ductwork construction, including all fittings and components, that complies with [SMACNA 1966](#), as supplemented and modified by this specification .

- b. Provide radius type elbows with a centerline radius of 1.5 times the width or diameter of the duct where space permits. Otherwise, elbows having a minimum radius equal to the width or diameter of the duct or square elbows with factory fabricated turning vanes are allowed.
- c. Provide ductwork that meets the requirements of Seal Class A. Provide ductwork in VAV systems upstream of the VAV boxes that meets the requirements of Seal Class A.
- e. Provide sealants that conform to fire hazard classification specified in Section [23 07 00](#) THERMAL INSULATION FOR MECHANICAL SYSTEMS and are suitable for the range of air distribution and ambient temperatures to which it is exposed. Do not use pressure sensitive tape as a sealant. Provide duct sealant products that meet either emissions requirements of [CDPH SECTION 01350](#) (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of [SCAQMD Rule 1168](#) (HVAC duct sealants are classified as "Other" within the [SCAQMD Rule 1168](#) sealants table). Provide validation of [indoor air quality for duct sealants](#).
- f. Make spiral lock seam duct, and flat oval with duct sealant and lock with not less than 3 equally spaced drive screws or other approved methods indicated in [SMACNA 1966](#). Apply the sealant to the exposed male part of the fitting collar so that the sealer is on the inside of the joint and fully protected by the metal of the duct fitting. Apply one brush coat of the sealant over the outside of the joint to at least [2 inch](#) band width covering all screw heads and joint gap. Dents in the male portion of the slip fitting collar are not acceptable.
- g. Fabricate outdoor air intake ducts and plenums with watertight soldered or brazed joints and seams.

2.9.1.1 Metallic Flexible Duct

- a. Provide duct that conforms to **UL 181** and **NFPA 90A** with factory-applied insulation, vapor barrier, and end connections. Provide duct assembly that does not exceed 25 for flame spread and 50 for smoke developed. Provide ducts designed for working pressures of **2 inches water gauge positive** and **1.5 inches water gauge negative**. Provide flexible round duct length that does not exceed **5 feet**. Secure connections by applying adhesive for **2 inches** over rigid duct, apply flexible duct **2 inches** over rigid duct, apply metal clamp, and provide minimum of three No. 8 sheet metal screws through clamp and rigid duct.
- b. Inner duct core: Provide interlocking spiral or helically corrugated flexible core constructed of zinc-coated steel, aluminum, or stainless steel; or constructed of inner liner of continuous galvanized spring steel wire helix fused to continuous, fire-retardant, flexible vapor barrier film, inner duct core.
- c. Insulation: Provide inner duct core that is insulated with mineral fiber blanket type flexible insulation, minimum of **1 inch** thick. Provide insulation covered on exterior with manufacturer's standard fire retardant vapor barrier jacket for flexible round duct.

2.9.1.2 Insulated Nonmetallic Flexible Duct Runouts

Use flexible duct runouts only where indicated. Runout length is indicated on the drawings, and is not to exceed **5 feet**. Provide runouts that are preinsulated, factory fabricated, and that comply with **NFPA 90A** and **UL 181**. Provide either field or factory applied vapor barrier. Provide not less than **20 ounce** glass fabric **duct connectors** coated on both sides with neoprene. Where coil induction or high velocity units are supplied with vertical air inlets, use a streamlined, vaned and mitered elbow transition piece for connection to the flexible duct or hose. Provide a die-stamped elbow and not a flexible connector as the last elbow to these units other than the vertical air inlet type. Insulated flexible connectors are allowed as runouts. Provide insulated material and vapor barrier that conform to the requirements of Section **23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS**. Do not expose the insulation material surface to the air stream.

2.9.1.3 General Service Duct Connectors

Provide a flexible duct connector approximately **6 inches** in width where sheet metal connections are made to fans or where ducts of dissimilar metals are connected. For round/oval ducts, secure the flexible material by stainless steel or zinc-coated, iron clinch-type draw bands. For rectangular ducts, install the flexible material locked to metal collars using normal duct construction methods. Provide a composite connector system that complies with **NFPA 701** and is classified as "flame-retardent fabrics" in **UL Bld Mat Dir**.

2.9.1.4 High Temperature Service Duct Connections

Provide material that is approximately **3/32 inch** thick, **35 to 40-ounce per square yard** weight, plain weave fibrous glass cloth with, nickel/chrome wire reinforcement for service in excess of **1200 degrees F**.

2.9.1.5 Aluminum Ducts

ASTM B209, alloy 3003-H14 for aluminum sheet and alloy 6061-T6 or equivalent strength for aluminum connectors and bar stock.

2.9.1.6 Copper Sheets

ASTM B152/B152M, light cold rolled temper.

2.9.1.7 Corrosion Resisting (Stainless) Steel Sheets

ASTM A167

2.9.2 Duct Access Doors

Provide hinged access doors conforming to **SMACNA 1966** in ductwork and plenums where indicated and at all air flow measuring primaries, automatic dampers, fire dampers, coils, thermostats, and other apparatus requiring service and inspection in the duct system. Provide access doors upstream and downstream of air flow measuring primaries and heating and cooling coils. Provide doors that are a minimum **15 by 18 inches**, unless otherwise shown. Where duct size does not accommodate this size door, make the doors as large as practicable. Equip doors **24 by 24 inches** or larger with fasteners operable from inside and outside the duct. Use insulated type doors in insulated ducts.

2.9.3 Fire Dampers

Use 1.5 hour rated fire dampers unless otherwise indicated. Provide fire dampers that conform to the requirements of **NFPA 90A** and **UL 555**. Perform the fire damper test as outlined in **NFPA 90A**. Provide a pressure relief door upstream of the fire damper. If the ductwork connected to the fire damper is to be insulated then provide a factory installed pressure relief damper. Provide automatic operating fire dampers with a dynamic rating suitable for the maximum air velocity and pressure differential to which it is subjected. Provide fire dampers approved for the specific application, and install according to their listing. Equip fire dampers with a steel sleeve or adequately sized frame installed in such a manner that disruption of the attached ductwork, if any, does not impair the operation of the damper. Equip sleeves or frames with perimeter mounting angles attached on both sides of the wall or floor opening. Construct ductwork in fire-rated floor-ceiling or roof-ceiling assembly systems with air ducts that pierce the ceiling of the assemblies in conformance with **UL Fire Resistance**. Provide curtain type with damper blades out of the air stream fire dampers. Install dampers that do not reduce the duct or the air transfer opening cross-sectional area. Install dampers so that the centerline of the damper depth or thickness is located in the centerline of the wall, partition or floor slab depth or thickness. Unless otherwise indicated, comply with the installation details given in **SMACNA 1819** and in manufacturer's instructions for fire dampers. Perform acceptance testing of fire dampers according to paragraph Fire Damper Acceptance Test and **NFPA 90A**.

2.9.4 Manual Balancing Dampers

Furnish manual balancing dampers with accessible operating mechanisms. Use chromium plated operators (with all exposed edges rounded) in finished portions of the building. Provide manual volume control dampers that are operated by locking-type quadrant operators. Install dampers that are 2

gauges heavier than the duct in which installed. Unless otherwise indicated, provide opposed blade type multileaf dampers with maximum blade width of 12 inches. Provide access doors or panels for all concealed damper operators and locking setscrews. Provide stand-off mounting brackets, bases, or adapters not less than the thickness of the insulation when the locking-type quadrant operators for dampers are installed on ducts to be thermally insulated, to provide clearance between the duct surface and the operator. Provide stand-off mounting items that are integral with the operator or standard accessory of the damper manufacturer.

2.9.5 Air Supply And Exhaust Air Dampers

Provide outdoor air supply and exhaust air dampers that have a maximum leakage rate when tested in accordance with AMCA 500-D as required by ASHRAE 90.1 - IP, including maximum Damper Leakage for:

- a. Climate Zones 1,2,6,7,8 the maximum damper leakage at 1.0 inch w.g. for motorized dampers is 4 cfm per square foot of damper area and non-motorized dampers are not allowed.
- b. All other Climate Zones the maximum damper leakage at 1.0 inch w.g. is 10 cfm per square foot and for non-motorized dampers is 20 cfm per square foot of damper area.

Dampers smaller than 24 inches in either direction may have leakage of 40 cfm per square foot.

2.9.6 Air Deflectors (Volume Extractors) and Branch Connections

Provide air deflectors (volume extractors) at all duct mounted supply outlets, at takeoff or extension collars to supply outlets, at duct branch takeoff connections, and at 90 degree elbows, as well as at locations as indicated on the drawings or otherwise specified. Conical branch connections or 45 degree entry connections are allowed in lieu of deflectors for branch connections. Furnish all air deflectors (volume extractors), except those installed in 90 degree elbows, with an approved means of adjustment. Provide easily accessible means for adjustment inside the duct or from an adjustment with sturdy lock on the face of the duct. When installed on ducts to be thermally insulated, provide external adjustments with stand-off mounting brackets, integral with the adjustment device, to provide clearance between the duct surface and the adjustment device not less than the thickness of the thermal insulation. Provide factory-fabricated air deflectors consisting of curved turning vanes or louver blades designed to provide uniform air distribution and change of direction with minimum turbulence or pressure loss. Provide factory or field assembled air deflectors (volume extractors). Make adjustment from the face of the diffuser or by position adjustment and lock external to the duct. Provide stand-off brackets on insulated ducts as described herein. Provide fixed air deflectors (volume extractors), also called turning vanes, in 90 degree elbows.

2.9.7 Plenums and Casings for Field-Fabricated Units

2.9.7.1 Plenum and Casings

Fabricate and erect plenums and casings as shown in SMACNA 1966, as applicable. Construct system casing of not less than 16 gauge galvanized sheet steel. Furnish cooling coil drain pans with 1 inch threaded outlet

to collect condensation from the cooling coils. Fabricate drain pans from not lighter than 16 gauge steel, galvanized after fabrication or of 18 gauge corrosion-resisting sheet steel conforming to ASTM A167, Type 304, welded and stiffened. Thermally insulate drain pans exposed to the atmosphere to prevent condensation. Coat insulation with a flame resistant waterproofing material. Provide separate drain pans for each vertical coil section, and a separate drain line for each pan. Size pans to ensure capture of entrained moisture on the downstream-air side of the coil. Seal openings in the casing, such as for piping connections, to prevent air leakage. Size the water seal for the drain to maintain a pressure of at least 2 inch water gauge greater than the maximum negative pressure in the coil space.

2.9.7.2 Casing

Terminate casings at the curb line and bolt each to the curb using galvanized angle, as indicated in SMACNA 1966.

2.9.7.3 Access Doors

Provide access doors in each section of the casing. Weld doorframes in place, gasket each door with neoprene, hinge with minimum of two brass hinges, and fasten with a minimum of two brass tension fasteners operable from inside and outside of the casing. Where possible, make doors 36 by 18 inches and locate them 18 inches above the floor. Where the space available does not accommodate doors of this size, use doors as large as the space accommodates. Swing doors so that fan suction or pressure holds doors in closed position, airtight. Provide a push-button station, located inside the casing, to stop the supply.

2.9.7.4 Factory-Fabricated Insulated Sheet Metal Panels

Factory-fabricated components are allowed for field-assembled units, provided all requirements specified for field-fabricated plenums and casings are met. Provide panels of modular design, pretested for structural strength, thermal control, condensation control, and acoustical control. Seal and insulate panel joints. Provide and gasket access doors to prevent air leakage. Provide panel construction that is not less than 20 gauge galvanized sheet steel, assembled with fasteners treated against corrosion. Provide standard length panels that deflect not more than 1/2 inch under operation. Construct details, including joint sealing, not specifically covered, as indicated in SMACNA 1966. Construct the plenums and casings to withstand the specified internal pressure of the air systems.

2.9.7.5 Duct Liner

Unless otherwise specified, duct liner is not permitted.

2.9.8 Sound Attenuation Equipment

2.9.8.1 Systems with total pressure above 4 Inches Water Gauge

Provide sound attenuators on the discharge duct of each fan operating at a total pressure above 4 inch water gauge, and, when indicated, at the intake of each fan system. Provide sound attenuators elsewhere as indicated. Provide factory fabricated sound attenuators, tested by an independent laboratory for sound and performance characteristics. Provide a net sound reduction as indicated. Maximum permissible pressure drop is

not to exceed 0.63 inch water gauge. Construct traps to be airtight when operating under an internal static pressure of 10 inch water gauge. Provide air-side surface capable of withstanding air velocity of 10,000 fpm. Certify that the equipment can obtain the sound reduction values specified after the equipment is installed in the system and coordinated with the sound information of the system fan to be provided. Provide sound absorbing material conforming to ASTM C1071, Type I or II. Provide sound absorbing material that meets the fire hazard rating requirements for insulation specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS. For connection to ductwork, provide a duct transition section. Factory fabricated double-walled internally insulated spiral lock seam and round duct and fittings designed for high pressure air system can be provided if complying with requirements specified for factory fabricated sound attenuators, in lieu of factory fabricated sound attenuators. Construct the double-walled duct and fittings from an outer metal pressure shell of zinc-coated steel sheet, 1 inch thick acoustical blanket insulation, and an internal perforated zinc-coated metal liner. Provide a sufficient length of run to obtain the noise reduction coefficient specified. Certify that the sound reduction value specified can be obtained within the length of duct run provided. Provide welded or spiral lock seams on the outer sheet metal of the double-walled duct to prevent water vapor penetration. Provide duct and fittings with an outer sheet that conforms to the metal thickness of high-pressure spiral and round ducts and fittings shown in SMACNA 1966. Provide acoustical insulation with a thermal conductivity "k" of not more than 0.27 Btu/inch/square foot/hour/degree F at 75 degrees F mean temperature. Provide an internal perforated zinc-coated metal liner that is not less than 24 gauge with perforations not larger than 1/4 inch in diameter providing a net open area not less than 10 percent of the surface.

2.9.8.2 System with total pressure of 4 Inch Water Gauge and Lower

Use sound attenuators only where indicated. Provide factory fabricated sound attenuators that are constructed of galvanized steel sheets. Provide attenuator with outer casing that is not less than 22 gauge. Provide fibrous glass acoustical fill. Provide net sound reduction indicated. Obtain values on a test unit not less than 24 by 24 inches outside dimensions made by a certified nationally recognized independent acoustical laboratory. Provide air flow capacity as indicated or required. Provide pressure drop through the attenuator that does not exceed the value indicated, or that is not in excess of 15 percent of the total external static pressure of the air handling system, whichever is less. Acoustically test attenuators with metal duct inlet and outlet sections while under the rated air flow conditions. Include with the noise reduction data the effects of flanking paths and vibration transmission. Construct sound attenuators to be airtight when operating at the internal static pressure indicated or specified for the duct system, but in no case less than 2 inch water gauge.

2.9.8.3 Acoustical Duct Liner

Use fibrous glass designed or flexible elastomeric duct liner for lining ductwork and conforming to the requirements of ASTM C1071, Type I and II. Provide uniform density, graduated density, or dual density liner composition, as standard with the manufacturer. Provide not less than 1 inch thick coated lining. Where acoustical duct liner is used, provide the thermal equivalent of the insulation specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS for liner or combination of liner and insulation applied to the exterior of the ductwork. Increase

duct sizes shown to compensate for the thickness of the lining used. In lieu of sheet metal duct with field-applied acoustical lining, provide acoustically equivalent lengths of fibrous glass duct, elastomeric duct liner or factory fabricated double-walled internally insulated duct with perforated liner.

2.9.9 Diffusers, Registers, and Grilles

Provide factory-fabricated units of aluminum that distribute the specified quantity of air evenly over space intended without causing noticeable drafts, air movement faster than 50 fpm in occupied zone, or dead spots anywhere in the conditioned area. Provide outlets for diffusion, spread, throw, and noise level as required for specified performance. Certify performance according to ASHRAE 70. Provide sound rated and certified inlets and outlets according to ASHRAE 70. Provide sound power level as indicated. Provide diffusers and registers with volume damper with accessible operator, unless otherwise indicated; or if standard with the manufacturer, an automatically controlled device is acceptable. Provide opposed blade type volume dampers for all diffusers and registers, except linear slot diffusers. Provide linear slot diffusers with round or elliptical balancing dampers. Where the inlet and outlet openings are located less than 7 feet above the floor, protect them by a grille or screen according to NFPA 90A.

2.9.9.1 Diffusers

Provide diffuser types indicated. Furnish ceiling mounted units with anti-smudge devices, unless the diffuser unit minimizes ceiling smudging through design features. Provide diffusers with air deflectors of the type indicated. Provide air handling troffers or combination light and ceiling diffusers conforming to the requirements of UL Electrical Construction for the interchangeable use as cooled or heated air supply diffusers or return air units. Install ceiling mounted units with rims tight against ceiling. Provide sponge rubber gaskets between ceiling and surface mounted diffusers for air leakage control. Provide suitable trim for flush mounted diffusers. For connecting the duct to diffuser, provide duct collar that is airtight and does not interfere with volume controller. Provide return or exhaust units that are similar to supply diffusers.

2.9.9.2 Security Ceiling Diffusers

Provide diffusers that are steel with faceplate, fixed diffusion louvers, with flat surface margin, and an opposed blade damper. Provide faceplate that is 14 gage minimum with 1/2 by 1/2 inch holes on 3/16 inch spacing and a minimum free area of 45 percent.

2.9.9.3 Registers and Grilles

Provide units that are four-way directional-control type, except provide return and exhaust registers that are fixed horizontal or vertical louver type similar in appearance to the supply register face. Furnish registers with sponge-rubber gasket between flanges and wall or ceiling. Install wall supply registers at least 6 inches below the ceiling unless otherwise indicated. Locate return and exhaust registers 6 inches above the floor unless otherwise indicated. Achieve four-way directional control by a grille face which can be rotated in 4 positions or by adjustment of horizontal and vertical vanes. Provide grilles as specified for registers, without volume control damper.

2.9.9.4 Security Supply Air Registers Except in Cells

Provide supply air registers, except in prisoner cells and prisoner holding cells, that are steel with individually adjustable horizontal and vertical vanes, perforated faceplate, flat surface margin and opposed blade damper. Put vertical vanes in front; with 3/4 inch o.c. vane spacing. Provide a 14 gage (minimum) perforated faceplate with 1/2 by 1/2 inch holes on 3/16 inch spacing and a minimum free area of 45 percent.

2.9.9.5 Security Return and Other Air Registers Except in Cells

Provide return, exhaust, transfer and relief air registers, except in prisoner cells and prisoner holding cells, that are steel with perforated faceplate, flat surface margin, opposed blade damper, and duct mounting sleeve. Provide 14 gage (minimum) faceplate with 1/2 by 1/2 inch holes on 3/16 inch spacing and a minimum free area of 45 percent.

2.9.9.6 Security Supply Air Registers in Cells

Provide supply air registers in prisoner cells and prisoner holding cells that are steel with perforated faceplate, flat surface margin, extension sleeve, opposed blade damper, and back mounting flanges. Provide a 14 gage (minimum) faceplate with 1/2 by 1/2 inch holes on 3/16 inch spacing and a minimum free area of 45 percent. Provide a 14 gage (minimum) wall sleeve.

2.9.9.7 Security Return and Other Type Air Registers in Cells

Provide steel return, exhaust, transfer and relief air registers in prisoner cells and prisoner holding cells with perforated faceplate, flat surface margin, wall sleeve, opposed blade damper, and back mounting flanges. Provide 14 gage (minimum) faceplate with 1/2 by 1/2 inch holes on 3/16 inch spacing and a minimum free area of 45 percent. Provide a 14 gage (minimum) wall sleeve.

2.9.10 Louvers

Provide louvers for installation in exterior walls that are associated with the air supply and distribution system as specified in Section 08 91 00 METAL WALL LOUVERS.

2.9.11 Air Vents, Penthouses, and Goosenecks

Fabricate air vents, penthouses, and goosenecks from galvanized steel sheets with galvanized structural shapes. Provide sheet metal thickness, reinforcement, and fabrication that conform to SMACNA 1966. Accurately fit and secure louver blades to frames. Fold or bead edges of louver blades for rigidity and baffle these edges to exclude driving rain. Provide air vents, penthouses, and goosenecks with bird screen.

2.9.12 Bird Screens and Frames

Provide bird screens that conform to ASTM E2016, No. 2 mesh, aluminum or stainless steel. Provide "medium-light" rated aluminum screens. Provide "light" rated stainless steel screens. Provide removable type frames fabricated from either stainless steel or extruded aluminum.

2.10 AIR SYSTEMS EQUIPMENT

2.10.1 Fans

Test and rate fans according to [AMCA 210](#). Calculate system effect on air moving devices in accordance with [AMCA 201](#) where installed ductwork differs from that indicated on drawings. Install air moving devices to minimize fan system effect. Where system effect is unavoidable, determine the most effective way to accommodate the inefficiencies caused by system effect on the installed air moving device. The sound power level of the fans must not exceed 85 dBA when tested according to [AMCA 300](#) and rated in accordance with [AMCA 301](#). Provide all fans with an AMCA seal. Connect fans to the motors either directly or indirectly with V-belt drive. Use V-belt drives designed for not less than 150 percent of the connected driving capacity. Provide variable pitch motor sheaves for [15 hp](#) and below, and fixed pitch as defined by [AHRI Guideline D](#) (A fixed-pitch sheave is provided on both the fan shaft and the motor shaft. This is a non-adjustable speed drive.). Select variable pitch sheaves to drive the fan at a speed which can produce the specified capacity when set at the approximate midpoint of the sheave adjustment. When fixed pitch sheaves are furnished, provide a replaceable sheave when needed to achieve system air balance. Provide motors for V-belt drives with adjustable rails or bases. Provide removable metal guards for all exposed V-belt drives, and provide speed-test openings at the center of all rotating shafts. Provide fans with personnel screens or guards on both suction and supply ends, except that the screens need not be provided, unless otherwise indicated, where ducts are connected to the fan. Provide fan and motor assemblies with vibration-isolation supports or mountings as indicated. Use vibration-isolation units that are standard products with published loading ratings. Select each fan to produce the capacity required at the fan static pressure indicated. Provide sound power level as indicated. Obtain the sound power level values according to [AMCA 300](#). Provide standard AMCA arrangement, rotation, and discharge as indicated. Provide power ventilators that conform to [UL 705](#) and have a UL label.

2.10.1.1 Centrifugal Fans

Provide fully enclosed, single-width single-inlet, or double-width double-inlet centrifugal fans, with AMCA Pressure Class I, II, or III as required or indicated for the design system pressure. Provide impeller wheels that are rigidly constructed and accurately balanced both statically and dynamically. Provide backward-inclined airfoil design fan blades for wheels over [30 inches](#) in diameter. Equip the fan shaft with a heat slinger to dissipate heat buildup along the shaft. Install an access (service) door to facilitate maintenance to these fans. Provide sleeve type, self-aligning and self-oiling bearings with oil reservoirs, or precision self-aligning roller or ball-type with accessible grease fittings or permanently lubricated type. Connect grease fittings to tubing for serviceability from a single accessible point. Provide L50 rated bearing life at not less than 200,000 hours as defined by [ABMA 9](#) and [ABMA 11](#). Provide steel, accurately finished fan shafts, with key seats and keys for impeller hubs and fan pulleys. Provide fan outlets of ample proportions, designed for the attachment of angles and bolts for attaching flexible connections. Unless otherwise indicated, provide motors that do not exceed 1800 rpm and have open or totally enclosed enclosures. Provide [manual across-the-line](#) type motor starters with weather-resistant enclosure.

2.10.1.2 Centrifugal Type Power Roof Ventilators

Provide direct or V-belt driven centrifugal type fans with backward inclined, non-overloading wheel. Provide hinged or removable and weatherproof motor compartment housing, constructed of heavy gauge aluminum. Provide fans with birdscreen, disconnect switch, gravity dampers, roof curb, and extended base. Provide dripproof type motor enclosure. Provide centrifugal type kitchen exhaust fans according to [UL 705](#) and [NFPA 96](#), fitted with V-belt drive, round hood, and windband upblast discharge configuration, integral residue trough and collection device, with motor and power transmission components located in outside positively air ventilated compartment. Use only lubricated bearings. If there is a conflict between NFPA 96 and UL 705 the most stringent wording must be adhered to.

2.10.1.3 Air-Curtain Fans

Refer to Section 11 06 40.13 - Food Service Equipment Schedule for coordinating information.

2.10.2 Coils

Provide fin-and-tube type coils constructed of seamless copper tubes and aluminum or [copper](#) fins mechanically bonded or soldered to the tubes. Provide copper tube wall thickness that is a minimum of [0.024 inches](#). Provide aluminum fins that are [0.0055 inch](#) minimum thickness.

Provide copper fins that are [0.0045 inch](#) minimum thickness. Provide casing and tube support sheets that are not lighter than [16 gauge](#) galvanized steel, formed to provide structural strength. When required, provide multiple tube supports to prevent tube sag. Mount coils for counterflow service. Rate and certify coils to meet the requirements of [AHRI 410](#). Provide factory applied phenolic, vinyl or epoxy/electrodeposition coating.

2.10.2.1 Direct-Expansion Coils

Provide suitable direct-expansion coils for the refrigerant involved. Provide refrigerant piping that conforms to [ASTM B280](#) and clean, dehydrate and seal. Provide seamless copper tubing suction headers or seamless or resistance welded steel tube suction headers with copper connections. Provide supply headers that consist of a distributor which distributes the refrigerant through seamless copper tubing equally to all circuits in the coil. Provide circuited tubes to ensure minimum pressure drop and maximum heat transfer. Provide circuiting that permits refrigerant flow from inlet to suction outlet without causing oil slugging or restricting refrigerant flow in coil. Provide field installed coils which are completely dehydrated and sealed at the factory upon completion of pressure tests. Pressure test coils in accordance with [UL 1995](#).

2.10.2.2 Water Coils

Install water coils with a pitch of not less than [1/8 inch/foot](#) of the tube length toward the drain end. Use headers constructed of cast iron, welded steel or copper. Furnish each coil with a plugged vent and drain connection extending through the unit casing. Provide removable water coils with drain pans. Pressure test coils in accordance with [UL 1995](#).

2.10.3 Air Filters

List air filters according to requirements of [UL 900](#), except list high efficiency particulate air filters of 99.97 percent efficiency by the DOP Test method under the Label Service to meet the requirements of [UL 586](#).

2.10.3.1 Extended Surface Pleated Panel Filters

Provide [2 inch](#) depth, sectional, disposable type filters of the size indicated with a MERV of 8 when tested according to [ASHRAE 52.2](#). Provide initial resistance at [500 fpm](#) that does not exceed [0.36 inches water gauge](#). Provide UL Class 2 filters, and nonwoven cotton and synthetic fiber mat media. Attach a wire support grid bonded to the media to a moisture resistant fiberboard frame. Bond all four edges of the filter media to the inside of the frame to prevent air bypass and increase rigidity.

2.10.3.2 Holding Frames

Fabricate frames from not lighter than [16 gauge](#) sheet steel with rust-inhibitor coating. Equip each holding frame with suitable filter holding devices. Provide gasketed holding frame seats. Make all joints airtight.

2.10.3.3 Filter Gauges

Provide dial type filter gauges, diaphragm actuated draft for all filter stations, including those filters which are furnished as integral parts of factory fabricated air handling units. Provide gauges that are at least [3-7/8 inches](#) in diameter, with white dials with black figures, and graduations with a minimum range of [1 inch of water](#) beyond the specified final resistance for the filter bank on which each gauge is applied. Provide each gauge with a screw operated zero adjustment and two static pressure taps with integral compression fittings, two molded plastic vent valves, two [5 foot](#) minimum lengths of [1/4 inch](#) diameter aluminum tubing, and all hardware and accessories for gauge mounting.

2.11 [AIR HANDLING UNITS](#) 2.11.1 Factory-Fabricated Air Handling Units

Provide single-zone draw-through type units as indicated. Units must include fans, coils, airtight insulated casing, prefilters, adjustable V-belt drives, belt guards for externally mounted motors, access sections where indicated, mixing box vibration-isolators, and appurtenances required for specified operation. Provide vibration isolators as indicated. Physical dimensions of each air handling unit must be suitable to fit space allotted to the unit with the capacity indicated. Provide air handling unit that is rated in accordance with [AHRI 430](#) and AHRI certified for cooling.

2.11.1.1 Casings

Provide the following:

- a. Casing sections [2 inch](#) double wall type, constructed of a minimum [18 gauge](#) galvanized steel, or [18 gauge](#) corrosion-resisting sheet steel conforming to [ASTM A167](#), Type 304. Design and construct casing with an integral insulated structural galvanized steel frame such that exterior panels are non-load bearing.

- b. Individually removable exterior panels with standard tools. Removal must not affect the structural integrity of the unit. Furnish casings with access sections, according to paragraph AIR HANDLING UNITS, inspection doors, and access doors, all capable of opening a minimum of 90 degrees, as indicated.
- c. Insulated, fully gasketed, double-wall type inspection and access doors, of a minimum 18 gauge outer and 20 gauge inner panels made of either galvanized steel or corrosion-resisting sheet steel conforming to ASTM A167, Type 304. Provide rigid doors with heavy duty hinges and latches. Inspection doors must be a minimum 12 inches wide by 12 inches high. Access doors must be a minimum 24 inches wide, the full height of the unit casing or a minimum of 6 foot, whichever is less. Install a minimum 8 by 8 inches sealed glass window suitable for the intended application, on the fan section access door.
- d. Double-wall insulated type drain pan (thickness equal to exterior casing) constructed of 16 gauge corrosion resisting sheet steel conforming to ASTM A167, Type 304, conforming to ASHRAE 62.1. Construct drain pans water tight, treated to prevent corrosion, and designed for positive condensate drainage. When 2 or more cooling coils are used, with one stacked above the other, condensate from the upper coils must not flow across the face of lower coils. Provide intermediate drain pans or condensate collection channels and downspouts, as required to carry condensate to the unit drain pan out of the air stream and without moisture carryover. Construct drain pan to allow for easy visual inspection, including underneath the coil without removal of the coil and to allow complete and easy physical cleaning of the pan underneath the coil without removal of the coil. Provide coils that are individually removable from the casing.
- e. Casing insulation that conforms to NFPA 90A. Insulate single-wall casing sections handling conditioned air with not less than 1 inch thick, 1-1/2 pound density coated fibrous glass material having a thermal conductivity not greater than 0.23 Btu/hr-sf-F. Insulate double-wall casing sections handling conditioned air with not less than 2 inches of the same insulation specified for single-wall casings. Foil-faced insulation is not an acceptable substitute for use with double wall casing. Seal double wall insulation completely by inner and outer panels.
- f. Factory applied fibrous glass insulation that conforms to ASTM C1071, except that the minimum thickness and density requirements do not apply, and that meets the requirements of NFPA 90A. Make air handling unit casing insulation uniform over the entire casing. Foil-faced insulation is not an acceptable substitute for use on double-wall access doors and inspections doors and casing sections.
- g. Duct liner material, coating, and adhesive that conforms to fire-hazard requirements specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS. Protect exposed insulation edges and joints where insulation panels are butted with a metal nosing strip or coat to meet erosion resistance requirements of ASTM C1071.
- h. A latched and hinged inspection door, in the fan and coil sections. Plus additional inspection doors, access doors and access sections where indicated.

2.11.1.2 Heating and Cooling Coils

Provide coils as specified in paragraph AIR SYSTEMS EQUIPMENT.

2.11.1.3 Air Filters

Provide air filters as specified in paragraph AIR SYSTEMS EQUIPMENT for types and thickness indicated.

2.11.1.4 Fans

Provide the following:

- a. Fans that are double-inlet, centrifugal type with each fan in a separate scroll. Dynamically balance fans and shafts prior to installation into air handling unit, then after it has been installed in the air handling unit, statically and dynamically balance the entire fan assembly. Mount fans on steel shafts, accurately ground and finished.
- b. Fan bearings that are sealed against dust and dirt and are precision self-aligning ball or roller type, with L50 rated bearing life at not less than 200,000 hours as defined by [ABMA 9](#) and [ABMA 11](#). Provide bearings that are permanently lubricated or lubricated type with lubrication fittings readily accessible at the drive side of the unit. Support bearings by structural shapes, or die formed sheet structural members, or support plates securely attached to the unit casing. Do not fasten bearings directly to the unit sheet metal casing. Furnish fans and scrolls with coating indicated.
- c. Fans that are driven by a unit-mounted, or a floor-mounted motor connected to fans by V-belt drive complete with belt guard for externally mounted motors. Furnish belt guards that are the three-sided enclosed type with solid or expanded metal face. Design belt drives for not less than a 1.3 service factor based on motor nameplate rating.
- e. Motor starters of manual [across-the-line](#) type with weather-resistant enclosure. Select unit fan or fans to produce the required capacity at the fan static pressure with sound power level as indicated. Obtain the sound power level values according to [AMCA 300](#), [ASHRAE 68](#), or [AHRI 260 I-P](#).

2.11.1.5 Access Sections and Filter/Mixing Boxes

Provide access sections where indicated and furnish with access doors as shown. Construct access sections and filter/mixing boxes in a manner identical to the remainder of the unit casing and equip with access doors. Design mixing boxes to minimize air stratification and to promote thorough mixing of the air streams.

2.12 TERMINAL UNITS

2.12.1 Variable Air Volume (VAV) and Dual Duct Terminal Units

- a. Provide VAV and dual duct terminal units that are the type, size, and capacity shown, mounted in the ceiling or wall cavity, plus units that are suitable for single or dual duct system applications. Provide actuators and controls as specified in paragraph SUPPLEMENTAL

COMPONENTS/SERVICES, subparagraph CONTROLS.

- b. Provide unit enclosures that are constructed of galvanized steel not lighter than 22 gauge or aluminum sheet not lighter than 18 gauge. Provide single or multiple discharge outlets as required. Units with flow limiters are not acceptable. Provide unit air volume that is factory preset and readily field adjustable without special tools. Provide reheat coils as indicated.
- c. Attach a flow chart to each unit. Base acoustic performance of the terminal units upon units tested according to AHRI 880 I-P with the calculations prepared in accordance with AHRI 885. Provide sound power level as indicated. Show discharge sound power for minimum and 1-1/2 inches water gauge inlet static pressure. Provide acoustical lining according to NFPA 90A.

2.12.1.1 Constant Volume, Single Duct Terminal Units

Provide constant volume, single duct, terminal units that contain within the casing, a constant volume regulator. Provide volume regulators that control air delivery to within plus or minus 5 percent of specified air flow subjected to inlet pressure from 3/4 to 6 inch water gauge.

2.12.1.2 Variable Volume, Single Duct Terminal Units

Provide variable volume, single duct, terminal units with a calibrated air volume sensing device, air valve or damper, actuator, and accessory relays. Provide units that control air volume to within plus or minus 5 percent of each air set point volume as determined by the thermostat with variations in inlet pressures from 3/4 to 6 inch water gauge. Provide units with an internal resistance not exceeding 0.4 inch water gauge at maximum flow range. Provide external differential pressure taps separate from the control pressure taps for air flow measurement with a 0 to 1 inch water gauge range.

2.12.1.3 Reheat Units

2.12.1.3.1 Hot Water Coils

Provide fin-and-tube type hot-water coils constructed of seamless copper tubes and copper or aluminum fins mechanically bonded or soldered to the tubes. Provide headers that are constructed of cast iron, welded steel or copper. Provide casing and tube support sheets that are 16 gauge, galvanized steel, formed to provide structural strength. Provide tubes that are correctly circuited for proper water velocity without excessive pressure drop and are drainable where required or indicated. At the factory, test each coil at not less than 250 psi air pressure and provide coils suitable for 200 psi working pressure. Install drainable coils in the air handling units with a pitch of not less than 1/8 inch per foot of tube length toward the drain end. Coils must conform to the provisions of AHRI 410.

2.13 SUPPLEMENTAL COMPONENTS/SERVICES

2.13.1 Chilled, Condenser, or Dual Service Water Piping

The requirements for chilled, condenser, or dual service water piping and accessories are specified in Section 23 64 26 CHILLED, CHILLED-HOT, AND CONDENSER WATER PIPING SYSTEMS

2.13.2 Refrigerant Piping

2.13.3 Water or Steam Heating System Accessories

The requirements for water or steam heating accessories such as expansion tanks and steam traps are specified in Section 23 21 13.00 20 LOW TEMPERATURE WATER (LTW) HEATING SYSTEM.

2.13.4 Condensate Drain Lines

Provide and install condensate drainage for each item of equipment that generates condensate in accordance with Section 22 00 00 PLUMBING, GENERAL PURPOSE except as modified herein.

2.13.5 Backflow Preventers

The requirements for backflow preventers are specified in Section 22 00 00 PLUMBING, GENERAL PURPOSE.

2.13.6 Insulation

The requirements for shop and field applied insulation are specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

2.13.7 Controls

The requirements for controls are specified in Section 23 05 93 TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS and Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC and Section 23 09 53.00 20 SPACE TEMPERATURE CONTROL SYSTEMS.

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing the work.

3.2 INSTALLATION

- a. Install materials and equipment in accordance with the requirements of the contract drawings and approved [manufacturer's installation instructions](#). Accomplish installation by workers skilled in this type of work. Perform installation so that there is no degradation of the designed fire ratings of walls, partitions, ceilings, and floors.
- b. No installation is permitted to block or otherwise impede access to any existing machine or system. Install all hinged doors to swing open a minimum of 120 degrees. Provide an area in front of all access doors that clears a minimum of [3 feet](#). In front of all access doors to electrical circuits, clear the area the minimum distance to energized circuits as specified in OSHA Standards, part 1910.333 (Electrical-Safety Related work practices) and an additional [3 feet](#).

- c. Except as otherwise indicated, install emergency switches and alarms in conspicuous locations. Mount all indicators, to include gauges, meters, and alarms in order to be easily visible by people in the area.

3.2.1 Condensate Drain Lines

Provide water seals in the condensate drain from all units . Provide a depth of each seal of 2 inches plus the number of inches, measured in water gauge, of the total static pressure rating of the unit to which the drain is connected. Provide water seals that are constructed of 2 tees and an appropriate U-bend with the open end of each tee plugged. Provide pipe cap or plug cleanouts where indicated. Connect drains indicated to connect to the sanitary waste system using an indirect waste fitting. Insulate air conditioner drain lines as specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

3.2.2 Equipment and Installation

Provide frames and supports for tanks, compressors, pumps, valves, air handling units, fans, coils, dampers, and other similar items requiring supports. Floor mount or ceiling hang air handling units as indicated. Anchor and fasten as detailed. Set floor-mounted equipment on not less than 6 inch concrete pads or curbs doweled in place unless otherwise indicated. Make concrete foundations heavy enough to minimize the intensity of the vibrations transmitted to the piping, duct work and the surrounding structure, as recommended in writing by the equipment manufacturer. In lieu of a concrete pad foundation, build a concrete pedestal block with isolators placed between the pedestal block and the floor. Make the concrete foundation or concrete pedestal block a mass not less than three times the weight of the components to be supported. Provide the lines connected to the pump mounted on pedestal blocks with flexible connectors. Submit foundation drawings as specified in paragraph DETAIL DRAWINGS. Provide concrete for foundations as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE.

3.2.3 Access Panels

Install access panels for concealed valves, vents, controls, dampers, and items requiring inspection or maintenance of sufficient size, and locate them so that the concealed items are easily serviced and maintained or completely removed and replaced. Provide access panels as specified in Section 08 31 00 ACCESS DOORS AND PANELS.

3.2.4 Flexible Duct

Install pre-insulated flexible duct in accordance with the latest printed instructions of the manufacturer to ensure a vapor tight joint. Provide hangers, when required to suspend the duct, of the type recommended by the duct manufacturer and set at the intervals recommended.

3.2.5 Metal Ductwork

Install according to SMACNA 1966 unless otherwise indicated. Install duct supports for sheet metal ductwork according to SMACNA 1966, unless otherwise specified. Do not use friction beam clamps indicated in SMACNA 1966. Anchor risers on high velocity ducts in the center of the vertical run to allow ends of riser to move due to thermal expansion. Erect supports on the risers that allow free vertical movement of the duct. Attach supports only to structural framing members and concrete

slabs. Do not anchor supports to metal decking unless a means is provided and approved for preventing the anchor from puncturing the metal decking. Where supports are required between structural framing members, provide suitable intermediate metal framing. Where C-clamps are used, provide retainer clips.

3.2.5.1 Underground Ductwork

Provide PVC plastisol coated galvanized steel underground ductwork with coating on interior and exterior surfaces and watertight joints. Install ductwork as indicated, according to [ACCA Manual 4](#) and manufacturer's instructions. Maximum burial depth is [6 feet](#).

3.2.6 Kitchen Exhaust Ductwork

3.2.6.1 Ducts Conveying Smoke and Grease Laden Vapors

Provide ducts conveying smoke and grease laden vapors that conform to requirements of [NFPA 96](#). Make seams, joints, penetrations, and duct-to-hood collar connections with a liquid tight continuous external weld. Provide duct material that is a minimum [18 gauge](#), Type 304L or 316L, stainless steel [or](#) minimum [16 gauge](#) carbon steel. Include with duct construction an external perimeter angle sized in accordance with [SMACNA 1966](#), except place welded joint reinforcement on maximum of [24 inch](#) centers; continuously welded companion angle bolted flanged joints with flexible ceramic cloth gaskets where indicated; pitched to drain at low points; welded pipe coupling-plug drains at low points; welded fire protection and detergent cleaning penetration; steel framed, stud bolted, and flexible ceramic cloth gasketed cleaning access provisions where indicated. Make angles, pipe couplings, frames, bolts, etc., the same material as that specified for the duct unless indicated otherwise.

3.2.6.2 Exposed Ductwork

Provide exposed ductwork that is fabricated from minimum [18 gauge](#), Type 304L or 316L, stainless steel with continuously welded joints and seams. Pitch ducts to drain at hoods and low points indicated. Match surface finish to hoods.

3.2.6.3 Concealed Ducts Conveying Moisture Laden Air

Fabricate concealed ducts conveying moisture laden air from minimum [18 gauge](#), Type 300 series, stainless steel. Continuously weld, braze, or solder joints to be liquid tight. Pitch ducts to drain at points indicated. Make transitions to other metals liquid tight, companion angle bolted and gasketed.

3.2.7 Acoustical Duct Lining

Apply lining in cut-to-size pieces attached to the interior of the duct with nonflammable fire resistant adhesive conforming to [ASTM C916](#), Type I, [NFPA 90A](#), [UL 723](#), and [ASTM E84](#). Provide top and bottom pieces that lap the side pieces and are secured with welded pins, adhered clips of metal, nylon, or high impact plastic, and speed washers or welding cup-head pins installed according to [SMACNA 1966](#). Provide welded pins, cup-head pins, or adhered clips that do not distort the duct, burn through, nor mar the finish or the surface of the duct. Make pins and washers flush with the surfaces of the duct liner and seal all breaks and punctures of the duct liner coating with the nonflammable, fire resistant adhesive. Coat

exposed edges of the liner at the duct ends and at other joints where the lining is subject to erosion with a heavy brush coat of the nonflammable, fire resistant adhesive, to prevent delamination of glass fibers. Apply duct liner to flat sheet metal prior to forming duct through the sheet metal brake. Additionally secure lining at the top and bottom surfaces of the duct by welded pins or adhered clips as specified for cut-to-size pieces. Other methods indicated in [SMACNA 1966](#) to obtain proper installation of duct liners in sheet metal ducts, including adhesives and fasteners, are acceptable.

3.2.8 Dust Control

To prevent the accumulation of dust, debris and foreign material during construction, perform temporary dust control protection. Protect the distribution system (supply and return) with temporary seal-offs at all inlets and outlets at the end of each day's work. Keep temporary protection in place until system is ready for startup.

3.2.9 Insulation

Provide thickness and application of insulation materials for ductwork, piping, and equipment according to Section [23 07 00](#) THERMAL INSULATION FOR MECHANICAL SYSTEMS. Externally insulate outdoor air intake ducts and plenums up to the point where the outdoor air mixes with the return air stream.

3.2.10 Duct Test Holes

Provide holes with closures or threaded holes with plugs in ducts and plenums as indicated or where necessary for the use of pitot tube in balancing the air system. Plug insulated duct at the duct surface, patched over with insulation and then marked to indicate location of test hole if needed for future use.

3.2.11 Power Roof Ventilator Mounting

Provide foamed [1/2 inch](#) thick, closed-cell, flexible elastomer insulation to cover width of roof curb mounting flange. Where wood nailers are used, predrill holes for fasteners.

3.2.12 Power Transmission Components Adjustment

Test V-belts and sheaves for proper alignment and tension prior to operation and after 72 hours of operation at final speed. Uniformly load belts on drive side to prevent bouncing. Make alignment of direct driven couplings to within 50 percent of manufacturer's maximum allowable range of misalignment.

3.3 EQUIPMENT PADS

Provide equipment pads to the dimensions shown or, if not shown, to conform to the shape of each piece of equipment served with a minimum [3-inch](#) margin around the equipment and supports. Allow equipment bases and foundations, when constructed of concrete or grout, to cure a minimum of 14 calendar days before being loaded.

3.4 CUTTING AND PATCHING

Install work in such a manner and at such time that a minimum of cutting

and patching of the building structure is required. Make holes in exposed locations, in or through existing floors, by drilling and smooth by sanding. Use of a jackhammer is permitted only where specifically approved. Make holes through masonry walls to accommodate sleeves with an iron pipe masonry core saw.

3.5 CLEANING

Thoroughly clean surfaces of piping and equipment that have become covered with dirt, plaster, or other material during handling and construction before such surfaces are prepared for final finish painting or are enclosed within the building structure. Before final acceptance, clean mechanical equipment, including piping, ducting, and fixtures, and free from dirt, grease, and finger marks. When the work area is in an occupied space such as office, laboratory or warehouse protect all furniture and equipment from dirt and debris. Incorporate housekeeping for field construction work which leaves all furniture and equipment in the affected area free of construction generated dust and debris; and, all floor surfaces vacuum-swept clean.

3.6 PENETRATIONS

Provide sleeves and prepared openings for duct mains, branches, and other penetrating items, and install during the construction of the surface to be penetrated. Cut sleeves flush with each surface. Place sleeves for round duct **15 inches** and smaller. Build framed, prepared openings for round duct larger than **15 inches** and square, rectangular or oval ducts. Sleeves and framed openings are also required where grilles, registers, and diffusers are installed at the openings. Provide **one inch** clearance between penetrating and penetrated surfaces except at grilles, registers, and diffusers. Pack spaces between sleeve or opening and duct or duct insulation with mineral fiber conforming with **ASTM C553**, Type 1, Class B-2.

3.6.1 Sleeves

Fabricate sleeves, except as otherwise specified or indicated, from **20 gauge** thick mill galvanized sheet metal. Where sleeves are installed in bearing walls or partitions, provide black steel pipe conforming with **ASTM A53/A53M**, Schedule 20.

3.6.2 Framed Prepared Openings

Fabricate framed prepared openings from **20 gauge** galvanized steel, unless otherwise indicated.

3.6.3 Insulation

Provide duct insulation in accordance with Section **23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS** continuous through sleeves and prepared openings except firewall penetrations. Terminate duct insulation at fire dampers and flexible connections. For duct handling air at or below **60 degrees F**, provide insulation continuous over the damper collar and retaining angle of fire dampers, which are exposed to unconditioned air.

3.6.4 Closure Collars

Provide closure collars of a minimum **4 inches** wide, unless otherwise indicated, for exposed ducts and items on each side of penetrated surface, except where equipment is installed. Install collar tight against the

surface and fit snugly around the duct or insulation. Grind sharp edges smooth to prevent damage to penetrating surface. Fabricate collars for round ducts 15 inches in diameter or less from 20 gauge galvanized steel. Fabricate collars for square and rectangular ducts, or round ducts with minimum dimension over 15 inches from 18 gauge galvanized steel. Fabricate collars for square and rectangular ducts with a maximum side of 15 inches or less from 20 gauge galvanized steel. Install collars with fasteners a maximum of 6 inches on center. Attach to collars a minimum of 4 fasteners where the opening is 12 inches in diameter or less, and a minimum of 8 fasteners where the opening is 20 inches in diameter or less.

3.6.5 Firestopping

Where ducts pass through fire-rated walls, fire partitions, and fire rated chase walls, seal the penetration with fire stopping materials as specified in Section 07 84 00 FIRESTOPPING.

3.7 FIELD PAINTING OF MECHANICAL EQUIPMENT

Clean, pretreat, prime and paint metal surfaces; except aluminum surfaces need not be painted. Apply coatings to clean dry surfaces. Clean the surfaces to remove dust, dirt, rust, oil and grease by wire brushing and solvent degreasing prior to application of paint, except clean to bare metal on metal surfaces subject to temperatures in excess of 120 degrees F. Where more than one coat of paint is specified, apply the second coat after the preceding coat is thoroughly dry. Lightly sand damaged painting and retouch before applying the succeeding coat. Provide aluminum or light gray finish coat.

3.7.1 Temperatures less than 120 degrees F

Immediately after cleaning, apply one coat of pretreatment primer applied to a minimum dry film thickness of 0.3 mil, one coat of primer applied to a minimum dry film thickness of one mil; and two coats of enamel applied to a minimum dry film thickness of one mil per coat to metal surfaces subject to temperatures less than 120 degrees F.

3.7.2 Temperatures between 120 and 400 degrees F

Apply two coats of 400 degrees F heat-resisting enamel applied to a total minimum thickness of two mils to metal surfaces subject to temperatures between 120 and 400 degrees F.

3.7.3 Temperatures greater than 400 degrees F

Apply two coats of 315 degrees C 600 degrees F heat-resisting paint applied to a total minimum dry film thickness of two mils to metal surfaces subject to temperatures greater than 400 degrees F.

3.7.4 Finish Painting

The requirements for finish painting of items only primed at the factory, and surfaces not specifically noted otherwise, are specified in Section 09 90 00 PAINTS AND COATINGS.

3.8 IDENTIFICATION SYSTEMS

Provide identification tags made of brass, engraved laminated plastic, or engraved anodized aluminum, indicating service and item number on all

valves and dampers. Provide tags that are 1-3/8 inch minimum diameter with stamped or engraved markings. Make indentations black for reading clarity. Attach tags to valves with No. 12 AWG 0.0808-inch diameter corrosion-resistant steel wire, copper wire, chrome-plated beaded chain or plastic straps designed for that purpose.

3.9 DUCTWORK LEAK TEST

Perform ductwork leak test for the entire air distribution and exhaust system, including fans, coils, filters, etc. Provide test procedure, apparatus, and report that conform to SMACNA 1972 CD. The maximum allowable leakage rate is 5% cfm. Complete ductwork leak test with satisfactory results prior to applying insulation to ductwork exterior or concealing ductwork.

3.10 DAMPER ACCEPTANCE TEST

Submit the proposed schedule, at least 2 weeks prior to the start of test. Operate all fire dampers and smoke dampers under normal operating conditions, prior to the occupancy of a building to determine that they function properly. Test each fire damper equipped with fusible link by having the fusible link cut in place. Test dynamic fire dampers with the air handling and distribution system running. Reset all fire dampers with the fusible links replaced after acceptance testing. To ensure optimum operation and performance, install the damper so it is square and free from racking.

3.11 TESTING, ADJUSTING, AND BALANCING

The requirements for testing, adjusting, and balancing are specified in Section 23 05 93 TESTING, ADJUSTING AND BALANCING FOR HVAC. Begin testing, adjusting, and balancing only when the air supply and distribution, including controls, has been completed, with the exception of performance tests.

3.12 PERFORMANCE TESTS

Conduct performance tests as required in Section 23 05 93 Testing, Adjusting and Balancing for HVAC and Section 23 09 00 Instrumentation and Control for HVAC.

3.13 CLEANING AND ADJUSTING

Provide a temporary bypass for water coils to prevent flushing water from passing through coils. Inside of air terminal units, thoroughly clean ducts, plenums, and casing of debris and blow free of small particles of rubbish and dust and then vacuum clean before installing outlet faces. Wipe equipment clean, with no traces of oil, dust, dirt, or paint spots. Provide temporary filters prior to startup of all fans that are operated during construction, and provide new filters after all construction dirt has been removed from the building, and the ducts, plenums, casings, and other items specified have been vacuum cleaned. Perform and document that proper "Indoor Air Quality During Construction" procedures have been followed; provide documentation showing that after construction ends, and prior to occupancy, new filters were provided and installed. Maintain system in this clean condition until final acceptance. Properly lubricate bearings with oil or grease as recommended by the manufacturer. Tighten belts to proper tension. Adjust control valves and other miscellaneous equipment requiring adjustment to setting indicated or directed. Adjust

fans to the speed indicated by the manufacturer to meet specified conditions. Maintain all equipment installed under the contract until close out documentation is received, the project is completed and the building has been documented as beneficially occupied.

3.14 OPERATION AND MAINTENANCE

3.14.1 Operation and Maintenance Manuals

Submit six manuals at least 2 weeks prior to field training. Submit data complying with the requirements specified in Section 01 78 23 OPERATION AND MAINTENANCE DATA. Submit Data Package 3 for the items/units listed under SD-10 Operation and Maintenance Data

3.14.2 Operation And Maintenance Training

Conduct a training course for the members of the operating staff as designated by the Contracting Officer. Make the training period consist of a total of 32 hours of normal working time and start it after all work specified herein is functionally completed and the Performance Tests have been approved. Conduct field instruction that covers all of the items contained in the Operation and Maintenance Manuals as well as demonstrations of routine maintenance operations. Submit the proposed On-site Training schedule concurrently with the Operation and Maintenance Manuals and at least 14 days prior to conducting the training course.

-- End of Section --

SECTION 23 31 13.00 40

METAL DUCTS
08/22

PART 1 GENERAL

Section 23 30 00 HVAC AIR DISTRIBUTION apply to work specified in this section.

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 325 (2017) Steel Construction Manual

AISC 360 (2016) Specification for Structural Steel Buildings

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE EQUIP IP HDBK (2012) Handbook, HVAC Systems and Equipment (IP Edition)

ASHRAE FUN IP (2021) Fundamentals Handbook, I-P Edition

AMERICAN WELDING SOCIETY (AWS)

AWS A5.8/A5.8M (2019) Specification for Filler Metals for Brazing and Braze Welding

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M (2019) Standard Specification for Carbon Structural Steel

ASTM A123/A123M (2017) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

ASTM A653/A653M (2022) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

ASTM A924/A924M (2022a) Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process

ASTM C1071 (2019) Standard Specification for Fibrous

Glass Duct Lining Insulation (Thermal and
Sound Absorbing Material)

ASTM D257

(2014) Standard Test Methods for D-C
Resistance or Conductance of Insulating
Materials

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 90A

(2021) Standard for the Installation of
Air Conditioning and Ventilating Systems

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION
(SMACNA)

SMACNA 1966

(2020) HVAC Duct Construction Standards
Metal and Flexible, 4th Edition

SMACNA 1987

(2006) HVAC Duct Systems Inspection Guide,
3rd Edition

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

SAE AMS 2480

(2009; Rev H) Phosphate Treatment, Paint,
Base

UNDERWRITERS LABORATORIES (UL)

UL 181

(2013; Reprint Dec 2021) UL Standard for
Safety Factory-Made Air Ducts and Air
Connectors

UL 555

(2006; Reprint Aug 2016) UL Standard for
Safety Fire Dampers

1.2 SUBMITTALS

Government approval is required for submittals. Submit the following in
accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Material, Equipment, and Fixture Lists;

Records of Existing Conditions;

SD-02 Shop Drawings

Connection Diagrams;

Offset Fitting Configurations;

SD-03 Product Data

Equipment and Performance Data

Galvanized Steel Ductwork Materials;

Brazing Materials

Mill-Rolled Reinforcing and Supporting Materials

Round Sheet Metal Duct Fittings;

Round, High-Pressure, Double-Wall Sheet Metal Ducts;

Turning Vanes; G

Flexible Connectors;

Flexible Duct Materials

Power-Operated Dampers;

Fire Dampers and Wall Collars;

Gravity Backdraft and Relief Dampers;

Manual Volume Dampers;

SD-05 Design Data

Design Analysis and Calculations;

SD-06 Test Reports

Ductwork Leakage Tests;

SD-07 Certificates

Listing of Product Installations

Galvanized Steel Ductwork Materials

Brazing Materials

Mill-Rolled Reinforcing and Supporting Materials

Round Sheet Metal Duct Fittings

Round, High-Pressure, Double-Wall Sheet Metal Ducts

Turning Vanes

Dampers

Flexible Connectors

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals;

Power Operated Dampers;

Fire Dampers and Wall Collars;

SD-11 Closeout Submittals

Record Drawings;

1.3 QUALITY CONTROL

When furnishing the [listing of product installations](#) for medium and high pressure ductwork systems include identification of at least 5 units, similar to those proposed for use, that have been in successful service for a minimum period of 5 years. Include purchaser, address of installation, service organization, and date of installation.

PART 2 PRODUCTS

Include the manufacturer's style or catalog numbers, specification and drawing reference numbers, warranty information, and fabrication site information within [material, equipment, and fixture lists](#).

2.1 SYSTEM DESCRIPTION

Provide low-pressure systems ductwork and plenums where maximum air velocity is [2,000-feet per minute \(fpm\)](#) and maximum static pressure is [2-inches](#) water gage (wg), positive or negative.

Submit [connection diagrams](#) for low pressure ductwork systems indicating the relation and connection of devices and apparatus by showing the general physical layout of all controls, the interconnection of one system (or portion of system) with another, and internal tubing, wiring, and other devices.

High velocity systems ductwork encompass systems where:

- a. Minimum air velocity exceeds [2,000-feet per minute \(fpm\)](#) or static pressure exceeds [2-inches water gage \(wg\)](#).
- b. Medium static pressure ranges from over [2-inches wg](#) through [3-inches wg](#), positive or negative, or over [3-inches wg](#) through [6-inches wg](#) positive.
- d. Do not use rigid fibrous-glass ductwork.

2.1.1 Design Requirements

Submit [records of existing conditions](#) including the results of a survey consisting of work area conditions, and features of existing structures and facilities within and adjacent to the jobsite.

Submit [equipment and performance data](#) for medium and high pressure ductwork systems consisting of use life, system functional flows, safety features, and mechanical automated details. Submit test response and performance characteristics curves for certified equipment.

Submit [design analysis and calculations](#) for ductwork systems indicating the manufacturer's recommended air velocities, maximum static pressure, and temperature calculations.

2.2 COMPONENTS

2.2.1 Round Sheet Metal Duct Fittings

Submit [offset fitting configurations](#) for approval. Shop fabricate fittings.

2.2.1.1 Fittings Construction

Manufacture as separate fittings, not as tap collars welded or brazed into duct sections.

Provide two-piece type miter elbows for angles less than 31 degrees, three-piece type for angles 31 through 60 degrees, and five-piece type for angles 61 through 90 degrees. Ensure centerline radius of elbows is 1-1/2 times fitting cross section diameter.

Provide conical type crosses, increasers, reducers, reducing tees, and 90-degree tees.

Ensure cutouts in fitting body are equal to branch tap dimension or, where smaller, excess material is flared and rolled into smooth radius nozzle configuration.

2.2.2 Round, High-Pressure, Double-Wall Sheet Metal Ducts

Shop fabricate ducts and fittings.

Construction comprises of an airtight, vapor barrier, outer pressure shell, a 1 inch insulation layer, and a metal inner liner that completely covers the insulation throughout the system.

Provide insulation conforming to NFPA 90A and ASTM C1071 for thermal conductivity in accordance with ASTM D257.

2.2.3 Reinforcement

Support inner liners of both duct and fittings by metal spacers welded in position to maintain spacing and concentricity.

2.2.4 Fittings

Make divided flow fittings as separate fittings, not tap collars into duct sections, with the following construction requirements:

- a. Sound, airtight, continuous welds at intersection of fitting body and tap
- b. Tap liner securely welded to inner liner, with weld spacing not to exceed 3-inches.
- c. Pack insulation around the branch tap area for complete cavity filling.
- d. Carefully fit branch connection to cutout openings in inner liner without spaces for air erosion of insulation and without sharp projections that cause noise and airflow disturbance.

Continuously braze seams in the pressure shell of fittings. Protect galvanized areas that have been damaged by welding with manufacturer's standard corrosion-resistant coating.

Construct two-piece type elbows for angles through 35 degrees, three-piece type for angles 36 through 71 degrees, and five-piece type for angles 72 through 90 degrees.

2.2.5 Turning Vanes

Provide double-wall type turning vanes, commercially manufactured for high-velocity system service.

2.2.6 Dampers

Construct low pressure drop, high-velocity manual volume dampers, and high-velocity fire dampers in accordance with [ASHRAE EQUIP IP HDBK](#), Chapter 16, [ASHRAE FUN IP](#), Chapter 32 and [SMACNA 1966](#).

2.2.7 Flexible Connectors for Sheet Metal

Use UL listed connectors, [30-ounce per square yard](#), waterproof, fire-retardant, airtight, woven fibrous-glass cloth, double coated with neoprene. Clear width, not including clamping section, is [6 to 8-inches](#).

2.2.8 Duct Hangers

For duct hangers in contact with galvanized duct surfaces, provide galvanized steel painted with inorganic zinc.

2.2.9 Mill-Rolled Reinforcing and Supporting Materials

Provide mill-rolled structural steel conforming to [ASTM A36/A36M](#). Whenever in contact with sheet metal ducting, provide galvanized steel in accordance with [ASTM A123/A123M](#).

In lieu of mill-rolled structural steel, submit equivalent strength, proprietary-design, rolled-steel structural support systems for approval.

2.2.10 Flexible Duct Materials

Ensure flexible duct connectors comply with [NFPA 90A](#), and conform with [UL 181](#), Class 1 material.

Provide aluminum zinc-coated [ASTM A123/A123M](#) metal duct; bendable through 180 degrees without damage, with an inside bend radius not greater than one-half the diameter of duct.

2.2.11 Manual Volume Dampers

Conform to [SMACNA 1966](#) for volume damper construction.

Equip dampers with an indicating quadrant regulator with a locking feature externally located and easily accessible for adjustment and standoff brackets to allow mounting outside external insulation. Where damper rod lengths exceed [30-inches](#), provide a regulator at each end of damper shaft.

2.2.11.1 Damper Construction

Provide all damper shafts with two-end bearings.

Ensure splitter damper is [22 -gage](#) sheet metal and is [2 gages](#) heavier than duct in which installed. Hinges are full length piano-type.

Provide a full length damper shaft and extend it beyond the damper blade. use a [3/8 -inch](#) square shaft for damper lengths up to [20 -inches](#) and a [1/2 -inch](#) square shaft for damper lengths [20 -inches](#) and larger. Where

necessary to prevent damper vibration or slippage, provide adjustable support rods with locking provisions external to duct at damper blade end.

Provide dampers in ducts having a width perpendicular to the axis of the damper that is greater than 12 -inches of multiblade type having a substantial frame with blades fabricated of 16 -gage metal. Provide blades not exceeding 10 -inches in width and 48 -inches in length, welded to 1/2 -inch diameter shafts. Ensure dampers greater than 48 -inches in width are made in two or more sections with intermediate mullions, each section being mechanically interlocked with the adjoining section or sections. Provide blades with graphite-impregnated nylon bearings and connect so that adjoining blades rotate in opposite directions.

2.2.12 Gravity Backdraft and Relief Dampers

Construct frames of not less than 1-1/2- by 4-inch reinforced 16-gage galvanized carbon steel. Solidly secure frames and mullions in place and seal with elastomer caulking against air bypass.

Provide shaft bearings with graphite-impregnated nylon .

Equip counterbalanced dampers with fixed or adjustable counterbalancing weights.

Gravity backdraft dampers may be equipment manufacturer's standard construction in sizes 18 by 18-inch or smaller, when furnished integral with air moving equipment.

2.2.12.1 Blade Construction

Maximum blade width is 9 inches, and maximum blade length is 36 -inches. Blade material is 16-gage galvanized steel. Provide blades with mechanically retained seals and 90-degree limit stops.

Blades linked together for relief service dampers are to open not less than 30 degrees on 0.05-inch wg differential pressure.

2.2.13 Power-Operated Dampers

Ensure dampers conform to applicable requirements

2.2.14 Fire Dampers and Wall Collars

Ensure fire damper locations are in accordance with NFPA 90A.

Provide fire dampers in ductwork at firewall barriers.

Construct and label fire dampers in accordance with UL 555 to provide damper and mounting fire-resistance that equals or exceeds fire-resistance of the construction in which installed. For link loads in excess of 20 pounds, provide UL-approved quartzoid links.

Construct wall collars in accordance with UL 555.

2.3 MATERIALS

2.3.1 Galvanized Steel Ductwork Materials

Provide hot-dip galvanized carbon steel ductwork sheet metal of lock-forming quality, with regular spangle-type zinc coating, conforming to [ASTM A924/A924M](#) and [ASTM A653/A653M](#), Designation G90. Treat duct surfaces to be painted by annealing.

Conform to [ASHRAE EQUIP IP HDBK](#), Chapter 16, [ASHRAE FUN IP](#), Chapter 32 and [SMACNA 1966](#) for sheet metal gages and reinforcement thickness.

Low pressure ductwork minimum thicknesses are:

MINIMUM SHEET METAL THICKNESS	
<u>DUCT WIDTH</u> <u>INCHES</u>	<u>GAGE</u>
0-12	26
13-30	24
31-60	22

2.3.2 Brazing Materials

Provide silicon bronze brazing materials conforming to [AWS A5.8/A5.8M](#).

2.3.3 Mill-Rolled Reinforcing and Supporting Materials

Conform to [ASTM A36/A36M](#) for mill-rolled structural steel. Wherever in contact with sheet metal ducting, galvanize to conforming with [ASTM A123/A123M](#).

In lieu of mill-rolled structural steel, submit for approval, equivalent strength, proprietary design, rolled-steel structural support systems.

2.3.4 Manufactured Round Or Flat Oval Ductwork (Positive Pressure)

Duct and fittings suitable to positive [10 inches WG](#). Ducts shall be machine formed round and/or flat oval as shown on drawings, constructed of G90 galvanized steel. Use spiral lockseam construction. Longitudinal seam construction may be used for ductwork over [80 inches](#) diameter with minimum [16 ga](#). Use fittings as indicated on drawings, as specified, and as required in accordance with manufacturer's published data.

Unless otherwise indicated, connection shall be slip type with minimum [2 inches](#) insertion length or flanged joint in accordance with manufacturer's recommendations. When flange joints are required, use Van Stone angle rings welded to duct. Internal bracing is not allowed.

PART 3 EXECUTION

3.1 PREPARATION

For sheet metal surfaces to be painted, and surfaces to which adhesives are to be applied, clean surface of oil, grease, and deleterious substances.

Ensure strength is adequate to prevent failure under service pressure or vacuum created by fast closure of duct devices. Provide leaktight,

automatic relief devices.

3.1.1 Construction Standards

Provide sheet metal construction in accordance with the recommendations for best practices in [ASHRAE EQUIP IP HDBK](#), Chapter 16, [ASHRAE FUN IP](#), Chapter 32, [SMACNA 1966](#), and [NFPA 90A](#).

Design and fabricate supplementary steel in accordance with [AISC 360](#) and [AISC 325](#).

Where construction methods for certain items are not described in the referenced standards or herein, perform the work in accordance with recommendations for best practice defined in [ASHRAE EQUIP IP HDBK](#).

3.2 INSTALLATION

Fabricate an airtight system. Include reinforcements, bracing, supports, framing, gasketing, sealing, and fastening to provide rigid construction and freedom from vibration, airflow-induced motion and noise, and excessive deflection at specified maximum system air pressure and velocity.

Provide offsets and transformations as required to avoid interference with the building construction, piping, or equipment.

Make plenum anchorage provisions, sheet metal joints, and other areas airtight and watertight by caulking, mating galvanized steel and concrete surfaces with a two-component elastomer.

3.2.1 Jointing

Enclose dampers located behind architectural intake or exhaust louvers by a rigid sheet metal collar and sealed to building construction with elastomers for complete air tightness.

Provide outside air-intake ducts and plenums made from sheet metal with soldered watertight joints.

3.2.2 Ducts

Wherever ducts pass through firewalls or through walls or floors dividing conditioned spaces from unconditioned spaces, provide a flanged segment in that surface during surface construction.

Where interiors of ducting may be viewed through air diffusion devices, construct the viewed interior with sheet metal and paint flat black.

3.2.2.1 Ductwork Cleaning Provisions

Protect open ducting from construction dust and debris in a manner approved by the Contracting Officer. Clean dirty assembled ducting by subjecting all main and branch interior surfaces to airstreams moving at velocities two times specified working velocities, at static pressures within maximum ratings. This may be accomplished by: filter-equipped portable blowers which remain the Contractor's property; wheel-mounted, compressed-air operated perimeter lances which direct the compressed air and which are pulled in the direction of normal airflow; or other means approved by the Contracting Officer. Use water- and oil- free compressed air for cleaning ducting. After construction is complete, and prior to

acceptance of the work, remove construction dust and debris from exterior surfaces. Clean in conformance with [SMACNA 1987](#).

3.3 APPLICATION

3.3.1 Low Pressure Sheet Metal Ducts

Weld angle iron frames at corners and ends, whenever possible. Rivet or weld angle iron reinforcements to ducts not more than [6-inches](#) on center, with not less than two points of attachment. Spot welding, where used, is [3-inches](#) on center.

Seal standard seam joints with an elastomer compound to comply with [SMACNA 1966](#) Seal Class A, B or C as applicable.

Limit crossbreaking to [4-feet](#) and provide on all ducts [8-inches](#) wide and wider. Provide bead reinforcement in lieu of crossbreaking where panel popping may occur. Where rigid insulation is applied, crossbreaking is not required.

3.3.1.1 Longitudinal Duct Seams

Provide Pittsburgh lock corner seams.

3.3.1.2 Joints and Gaskets

Bolt companion angle flanges together with [1/4 -inch](#) diameter bolts and nuts spaced [6 -inches](#) on center. Gasket flanged joints with neoprene full-face gaskets [1/8 -inch](#) thick, with Shore A 40 durometer hardness. Use one piece gaskets, vulcanized [dovetailed](#) at joints.

3.3.1.3 Flexible Duct Joints

Between flexible duct without sheet metal collars and round metal ductwork connections make joints by trimming the ends, coating the inside of the flexible duct for a distance equal to depth of insertion with elastomer caulk, and by securing with sheet metal screws or binding with a strap clamp.

3.3.1.4 Square Elbows

Provide double-vane duct turns in accordance with [SMACNA 1966](#).

3.3.1.5 Radius Elbows

Conform to [SMACNA 1966](#) for radius elbows. Provide an inside radius equal to the width of the duct. Where installation conditions preclude use of standard elbows, the inside radius may be reduced to a minimum of 0.25 times duct width. Install turning vanes in accordance with the following schedule.

	RADIUS OF TURNING VANES IN PERCENT OF DUCT WIDTH		
WIDTH OF ELBOWS INCHES	VANE NO. 1	VANE NO. 2	VANE NO. 3
Up to 16	56	--	--

	RADIUS OF TURNING VANES IN PERCENT OF DUCT WIDTH		
17 to 48	43	73	--
49 and over	37	55	83

Where two elbows are placed together in the same plane for ducts 30-inches wide and larger, continue the guide vanes through both elbows rather than spaced in accordance with above schedule.

3.3.1.6 Outlets, Inlets, and Duct Branches

Install branches, inlets, and outlets so that air turbulence is reduced to a minimum and air volume properly apportioned. Install adjustable splitter dampers at all supply junctions to permit adjustment of the amount of air entering the branch. Wherever an air-diffusion device is shown as being installed on the side, top, or bottom of a duct, and whenever a branch take-off is not of the splitter type; provide a commercially manufactured 45 degree side-take-off (STO) fitting with manual volume damper to allow adjustment of the air quantity and to provide an even flow of air across the device or duct it services.

Where a duct branch is to handle more than 25 percent of the air handled by the duct main, use a complete 90-degree increasing elbow with an inside radius of 0.75 times branch duct width. Size of the leading end of the increasing elbow within the main duct with the same ratio to the main duct size as the ratio of the related air quantities handled.

Where a duct branch is to handle 25 percent or less of the air handled by the duct main, construct the branch connection with a 45 degree side take-off entry in accordance with [SMACNA 1966](#).

3.3.1.7 Duct Transitions

Where the shape of a duct changes, ensure the angle of the side of the transition piece does not exceed 15 degrees from the straight run of duct connected thereto.

Where equipment is installed in ductwork, ensure the angle of the side of the transition piece from the straight run of duct connected thereto does not exceed 15 degrees on the upstream side of the equipment and 22-1/2 degrees on the downstream side of the equipment.

3.3.1.8 Branch Connections

Construct radius tap-ins in accordance with [SMACNA 1966](#).

3.3.1.9 Access Openings

Construct access door in accordance with [SMACNA 1966](#), except that sliding doors may be used only for special conditions upon prior approval. Provide double-panel type doors.

Install access doors and panels in ductwork upstream from coils, adjacent to fire dampers, [and](#) where indicated, and every 20-feet for indoor air quality housekeeping purposes.

Minimum access opening size is 12 by 18 -inches, unless precluded by duct dimensions or otherwise indicated.

Make airtight access doors that leak by adding or replacing hinges and latches or by construction of new doors adequately reinforced, hinged, and latched.

3.3.1.10 Plenum Construction

Provide intake and discharge plenum companion angle joints with the following minimum thickness of materials:

<u>LONGEST ANGLES SIDE INCHES</u>	<u>SHEET METAL USS GAGE ALL SIDES</u>	<u>COMPANION ANGLES INCHES</u>	<u>REINFORCEMENT 24 INCHES ON CENTER MAXIMUM</u>
To 48	20	1-1/2 by 1-1/2 by 1/8	1-1/2 by 1-1/2 by 1/8
49 to 84	18	2 by 2 by 1/8	2 by 2 by 3/16
85 to 120	16	2 by 2 by 1/8	2 by 2 by 1/8
121 and larger	14	2 by 2 by 3/16	2 by 2 by 3/16

At the floor line and other points where plenums join masonry construction, bolt panels 12 -inches on center to 2- by 2- by 3/16 -inch thick hot-dip galvanized steel angle that has been secured to the masonry with masonry anchors and bolts 24-inches on center and caulked tight to the masonry.

Anchor panels to curbing with hot-dip galvanized steel angle iron of a size not less than 2- by 2- by 3/16 -inch thick. Concrete curbing includes angle iron nosing with welded studs for the anchoring of panels. Level nosing at curb height within plus or minus 1/16 -inch.

Weld and grind miter corners for angle iron and channel iron.

3.3.1.11 Plenum Door Construction

Construct plenum access doors in accordance with SMACNA 1966 except that access doors smaller than man-access doors have door openings framed with angle iron that is one commercial size smaller than the specified panel reinforcement.

Ensure man-access door size conforms to SMACNA 1966 and paragraph ACCESS OPENINGS. Insulated and uninsulated construction is per SMACNA 1966. Frame door openings with channel iron. Frame doors with angle iron. Size channel iron and angle iron approximately the same size as specified panel reinforcement. Provide exterior door skin 16 gage. Fabricate latches from steel with hinges at least 4 -inches long, and bolts at least 3/8 -inch diameter.

3.3.1.12 Manual Volume Dampers

Provide balancing dampers of the splitter, butterfly, or multilouver type, to balance each respective main and branch duct.

For dampers regulated through ceilings provide a regulator concealed in a box mounted in the ceiling, with a cover finish aesthetically compatible with ceiling surface. Where ceiling is of removable construction, set

regulators above the ceiling, and mark the location on ceiling in a manner acceptable to the Contracting Officer.

3.3.1.13 Flexible Connectors for Sheet Metal

Connect air handling equipment, ducts crossing building expansion joints, and fan inlets and outlets to upstream and downstream components by treated woven-cloth connectors.

Install connectors only after system fans are operative, and vibration isolation mountings have been adjusted. When system fans are operating, ensure connectors are free of wrinkles caused by misalignment or fan reaction. Width of surface is curvilinear.

3.3.2 Rectangular Sheet Metal Ducts

3.3.2.1 Medium-Pressure Gages, Joints, and Reinforcement

Ensure minimum sheet metal gages, joints, and reinforcements between joints are in accordance with **ASHRAE EQUIP IP HDBK**, Chapter 16, **ASHRAE FUN IP**, Chapter 32 and **SMACNA 1966**.

Ensure sheet metal minimum thickness, transverse reinforcement between joints, and joints of ducts are in accordance with the following:

LONGEST SIDE (INCHES)	SHEET METAL GAGE ALL SIDES	COMPANION ANGLE (INCHES)	REINFORCEMENT ANGLES 24 INCHES ON CENTER MAXIMUM (BACK TO BACK)
97 to 108	16	2 by 2 by 1/8, two tie rods along angle	Two 2 by 2 by 1/8, two tie rods along angle
109 to 132	16	2 by 2 by 3/16, two tie rods along angle	Two 2 by 2 by 3/16, two tie rods along angle
133 and longer	14	2 by 2 by 3/16, with tie rods every 48 inches	Two 2 by 2 by 3/16, with tie rods every 48 inches

3.3.2.2 Medium- And High-Pressure Branches, Inlets, Outlets

Install branches, inlets, and outlets to minimize air turbulence and to ensure proper airflow.

Install dampers so that the amount of air entering duct mains is adjustable.

Provide commercially manufactured air extractors to allow adjustment of the air quantity and to provide an even flow of air across the device or duct served.

3.3.2.3 Duct Branch Transition

Where a duct branch handles over 25 percent of the air transported by the duct main, use a complete 90-degree increasing elbow, with an inside radius of 0.75 times duct branch width. Ensure the size of the trailing end of the increasing elbow within the main duct has the same ratio to the

main duct size as the ratio of the relative air quantities handled.

Where a duct branch is to handle 25 percent or less of the air handled by the duct main, provide a branch connection with an inside radius of 0.75 times branch duct width, a minimum arc length of 45 degrees, and an outside radius of 1.75 times duct branch width. Place arc tangent to duct main.

3.3.2.4 High-Pressure Gages, Joints, and Reinforcement

Ensure sheet metal minimum thickness, joints, and reinforcement between joints are in accordance with [ASHRAE EQUIP IP HDBK](#), Chapter 16, [ASHRAE FUN IP](#), Chapter 32 and [SMACNA 1966](#).

Use the following types of [ASHRAE EQUIP IP HDBK](#), Chapter 16, [ASHRAE FUN IP](#), Chapter 32 and [SMACNA 1966](#) joints and seams:

Transverse Joints:

- a. Welded flange joint with angle
- b. Companion angle flanged joint

Longitudinal Seams:

- a. Approved lock seams, back brazed, or continuously brazed seams for ducts with largest dimension up to [72-inches](#)
- b. Continuously welded or brazed seams for ducts with largest dimension greater than [72-inches](#)

Sheet metal minimum thickness, transverse reinforcement between joints, and companion angle joints of ducts with longest side greater than [96 inches](#) are in accordance with the following:

LONGEST SIDE (inches)	SHEET METAL GAGE ALL SIDES	COMPANION ANGLE (inches)	REINFORCEMENT ANGLES 24 INCHES ON CENTER MAXIMUM (BACK TO BACK)
97 to 108	16	2 by 2 by 1/8, two tie rods along angle	*Two 2 by 2 by 1/8, two tie rods along angle
109 to 132	16	2 by 2 by 3/16, two tie rods along angle	*Two 2 by 2 by 3/16, two tie rods along angle
133 and longer	14	2-1/2 by 2-1/2 by 3/16, with tie rods every 24 inches	*Two 2-1/2 by 2-1/2 by 3/16, with tie rods every 24 inches

3.3.3 Round Sheet Metal Ducts

3.3.3.1 Duct Gages and Reinforcement

Sheet metal minimum thickness, joints, and reinforcement between joints

shall be in accordance with **ASHRAE EQUIP IP HDBK**, Chapter 16, **ASHRAE FUN IP**, Chapter 32 and **SMACNA 1966**.

Provide ducts with supplemental girth angle supports, riveted with solid rivets **6 inches** on center to duct. Locate girth angles as follows:

<u>DIAMETER, INCHES</u>	<u>REINFORCEMENT-MAXIMUM SPACING INCHES</u>
25 to 36	1-1/4 by 1-1/4, 1/8 thick, 72 inches on center
37 to 50	1-1/4 by 1-1/4, 1/8 thick, 60 inches on center
51 to 60	1-1/2 by 1-1/2, 1/8 thick, 48 inches on center

Use hex-shaped bolt heads and nuts, **5/16-inch diameter** for ducts up to **50-inch** diameter, and **3/8-inch diameter** for **51-inch** diameter ducts and larger.

Continuously weld flanges to duct on outside of duct and intermittently welded with **1-inch** welds every **4-inches** on inside joint face. Remove excess filler metal from inside face. Protect galvanized areas that have been damaged by welding with manufacturer's standard corrosion-resistant coating.

3.3.3.2 Duct Joints

Provide duct joints manufactured by machine, with spiral locksets up to and including **60-inch** diameters, and to dimensional tolerances compatible with fittings provided. Draw-band girth joints are not acceptable.

Prepare slip joints by coating the male fitting with elastomer sealing materials, exercising care to prevent mastic from entering fitting bore. Leave only a thin annular mastic line exposed internally. Use sheet metal screws to make assembly rigid, not less than four screws per joint, maximum spacing **6-inches**. Do not use pop rivets. Tape and heat seal all joints.

3.3.3.3 Duct Transitions

Where the shape of a duct changes, ensure the angle of the side of the transition piece does not exceed 15 degrees from the straight run of duct connected thereto.

3.3.4 Round, High Pressure, Sheet Metal Duct Installation

3.3.4.1 Joints

Provide an inner coupling to align the inner lining to maintain good airflow conditions equivalent to standard round high-pressure duct joints. Butt joints are not suitable for the inner liner. Accomplish this alignment by the use of a double concentric coupling with the two couplings held by spacers for rigidity and wall spacing. For ducts over

34-inches inside diameter, provide a separate coupling for inner alignment, with the pressure shells joined by angle-ring flanged connections.

3.3.4.2 Insulation Ends

At the end of an uninsulated section or run where internally insulated duct connects to uninsulated spiral duct, fitting, fire damper or flexible duct, install an insulated end-fitting to bring the outer pressure shell down to nominal size.

3.3.5 Transverse Reinforcement Joints

Provide transverse reinforcements that are riveted with solid rivets to duct sides **6 inches** on center . Weld transverse reinforcement at all corners to form continuous frames.

3.3.6 Joint Gaskets

For flanged joints, use neoprene full-face gaskets **1/8-inch** thick, with Shore A 40 durometer hardness. Use one-piece gaskets, **vulcanized or dovetailed** at joints.

3.3.7 Radius Elbows

Fabricate elbow proportions and radius elbows in accordance with **ASHRAE EQUIP IP HDBK**, Chapter 16, **ASHRAE FUN IP**, Chapter 32 and **SMACNA 1966**.

3.3.8 Plenum Connections

Ensure round duct connections are welded joint bellmouth type.

Ensure rectangular duct connections are bellmouth type, constructed in accordance with **ASHRAE EQUIP IP HDBK**, Chapter 16, **ASHRAE FUN IP**, Chapter 32 and **SMACNA 1966**.

3.3.9 Access Openings

Install access panels in ductwork adjacent to fire dampers.

Minimum size of access opening is **12 by 18 inches**, unless precluded by duct dimension.

Frame access openings with welded and ground miter joints, **1/8-inch** thick angle iron, with **1/4 -inch** studs welded to frame. Ensure cover plates are not less than **16-gage**, reinforced as necessary for larger sizes .

In lieu of access doors, use readily accessible flanged duct sections upon approval. Provide stable hanger supports for disconnected duct terminal.

3.3.10 Duct Supports

Install duct support in accordance with **ASHRAE EQUIP IP HDBK**, Chapter 16, **ASHRAE FUN IP**, Chapter 32 and **SMACNA 1966**. Meet the minimum size for duct hangers as specified in **ASHRAE EQUIP IP HDBK**, Chapter 16, **ASHRAE FUN IP**, Chapter 32 and **SMACNA 1966**. Provide two hangers where necessary to eliminate sway. Support attachment to duct surfaces by welding **4-inches** on center.

Take the following into account in selection of a hanging system:

- a. Location and precedence of work under other sections
- b. Interferences of various piping and electrical conduit
- c. Equipment, and building configuration
- d. Structural and safety factor requirements
- e. Vibration, and imposed loads under normal and abnormal service conditions

Support sizes, configurations, and spacing are given to show the minimal type of supporting components required. If installed loads are excessive for the specified hanger spacing, hangers, and accessories provide heavier-duty components. After system startup, replace any duct support device which due to length, configuration, or size, vibrates or causes possible failure of a member. Do not use a ductwork support system that allows a cascade-type failure to occur.

Do not hang ductwork and equipment from roof deck, piping, or other ducts or equipment. Maximum span between any two points is **10-feet**, with lesser spans as required by duct assemblies, interferences, and permitted loads imposed.

3.3.10.1 Double-wall Ducts

Provide round, double-wall duct supports as recommended by the manufacturer except that minimum hanger ring and strap size is **1-1/2 inches by 1/8 inch**.

3.3.10.2 Hangars

Attach hanger rods, angles, and straps to beam clamps. Receive approval from the Contracting Officer for concrete inserts, masonry anchors, and fasteners for the application.

Hardened high-carbon spring-steel fasteners fitted onto beams and miscellaneous structural steel are acceptable upon prior approval of each proposed application and upon field demonstration of conformance to specification requirements. Make fasteners from steel conforming to AISI Type 1055, treated and finished in conformance with **SAE AMS 2480**, Type Z (zinc phosphate base), Class 2 (supplementary treatment). Verify a 72-hour load-carrying capacity by a certified independent laboratory.

Where ductwork system contains heavy equipment, excluding air-diffusion devices and single-leaf dampers, hang such equipment independently of the ductwork by means of rods or angles of sizes adequate to support the load.

Cross-brace hangers to preclude swaying both vertically and laterally.

3.3.10.3 Installation

Ensure hanger spacing gives a 20-to-1 safety factor for supported load.

Maximum load supported by any two fasteners is **100 pounds**.

Install hangers on both sides of all duct turns, branch fittings, and

transitions.

Friction rod assemblies are not acceptable.

3.3.10.4 Strap-type Hangers

Support rectangular ducts up to 36-inches by strap-type hangers attached at not less than three places to not less than two duct surfaces in different planes.

Perforated strap hangers are not acceptable.

3.3.10.5 Trapeze Hangers

Support rectangular ducting, 36-inches and larger, by trapeze hangers. Support ducts situated in unconditioned areas and required to have insulation with a vapor-sealed facing on trapeze hangers. Space hangers far enough out from the side of the duct to permit the duct insulation to be placed on the duct inside the trapeze. Do not penetrate the vapor-sealed facing with duct hangers.

Where trapeze hangers are used, support the bottom of the duct on angles sized as follows:

<u>WIDTH OF DUCT,</u> <u>INCHES</u>	<u>MINIMUM BOTTOM ANGLE SIZE,</u> <u>INCHES</u>
30 and smaller	1-1/4 by 1-1/4 by 1/8
31 to 48	1-1/2 by 1-1/2 by 1/8
49 to 72	1-1/2 by 1-1/2 by 3/16
73 to 96	2 by 2 by 1/4
97 and wider	3 by 3 by 1/4

3.3.10.6 Purlins

Do not support ducting from roof purlins at points greater than one-sixth of the purlin span from the roof truss. Do not exceed 400 pounds load per hanger.

If the hanger load must exceed the above limit, provide reinforcing of purlin(s) or additional support beam(s). When an additional beam is used, have the beam bear on the top chord of the roof trusses, and also bear over the gusset plates of top chord. Stabilize the beam by connection to roof purlin along bottom flange.

Purlins used for supporting fire-protection sprinkler mains, electrical lighting fixtures, electrical power ducts, or cable trays are considered fully loaded. Provide supplemental reinforcing or auxiliary support steel for these purlins when used to support ductwork.

3.3.10.7 Vibration Isolation

Provide vibration isolators in discharge ducting system for a distance not less than 50-feet beyond the air handling unit. Coordinate deflection of duct and equipment mountings.

3.3.11 Flexible Connectors for Steel Metal

Connect air-handling equipment, ducts crossing building expansion joints, and fan inlets and outlets to upstream and downstream components with treated woven-cloth connectors.

Install connectors only after system fans are operative and all vibration isolation mountings have been adjusted. When system fans are operating, ensure connectors are free of wrinkles caused by misalignment or fan reaction. Width of surface is curvilinear.

3.3.12 Insulation Protection Angles

Provide galvanized 20-gage sheet, formed into an angle with a 2-inch exposed long leg with a 3/8-inch stiffening break at outer edge, and with a variable concealed leg, depending upon insulation thickness.

Install angles over all insulation edges terminating by butting against a wall, floor foundation, frame, and similar construction. Fasten angles in place with blind rivets through the protection angle, insulation, and sheet metal duct or plenum. Install angles after final insulation covering has been applied.

3.3.13 Duct Probe Access

Provide holes with neat patches, threaded plugs, or threaded or twist-on caps for air-balancing pitot tube access. Provide extended-neck fittings where probe access area is insulated.

3.3.14 Openings In Roofs and Walls

Existing building openings are fixed in size and cannot be resized without authorization. Provide equipment to suit existing opening size.

3.4 FIELD QUALITY CONTROL

3.4.1 Ductwork Leakage Tests

Conduct complete leakage test of new ductwork in accordance with Section 23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC. Perform tests prior to installing ductwork insulation.

3.4.2 Inspection

Inspect ductwork in accordance with SMACNA 1987.

3.5 CLOSEOUT ACTIVITIES

3.5.1 Operation and Maintenance

Submit 6 copies of the operation and maintenance manuals 30 calendar days prior to testing the medium and high pressure ductwork systems. Update data and resubmit for final approval no later than 30 calendar days prior to contract completion.

Ensure operation and maintenance manuals are consistent with manufacturer's standard brochures, schematics, printed instructions, general operating procedures and safety precautions.

3.5.2 Record Drawings

Provide **record drawings** with current factual information. Include deviations from, and amendments to, the drawings. Include concealed or visible changes in the work. Label drawings "As-Built".

-- End of Section --

SECTION 23 34 23.00 40

HVAC POWER VENTILATORS
02/17

PART 1 GENERAL

Provide a power roof ventilators complete with all components and accessory equipment as specified in this section.

Section 23 30 00 HVAC AIR DISTRIBUTION applies to work specified in this section.

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7-16 (2017; Errata 2018; Supp 1 2018) Minimum Design Loads and Associated Criteria for Buildings and Other Structures

ASTM INTERNATIONAL (ASTM)

ASTM A653/A653M (2022) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

ASTM B37 (2018) Standard Specification for Aluminum for Use in Iron and Steel Manufacture

ASTM B209 (2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA)

RCBEA GUIDE (2004) NASA Reliability Centered Building and Equipment Acceptance Guide

UNDERWRITERS LABORATORIES (UL)

UL 705 (2017; Reprint Aug 2022) UL Standard for Safety Power Ventilators

1.2 SUBMITTALS

Government approval is required for submittals. . Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Shop Drawings;

Installation Drawings;

SD-03 Product Data

Housing;
Fan;
Motor;
Bases;
Roof Curbs;
Dampers;
Screens;
Sound Baffles;

SD-11 Closeout Submittals

Record Drawings;

1.3 QUALITY CONTROL

Rate and label ventilators in accordance with the applicable standards of the Air Movement Control Association (AMCA), and indicate if the license bears the AMCA seal for both air and sound.

1.3.1 Predictive Testing and Inspection Technology Requirements

This section contains systems or equipment components regulated by NASA's Reliability Centered Building and Equipment Acceptance Program (RCBEA). This program requires the use of Predictive Testing and Inspection (PT&I) technologies in conformance with the RCBEA GUIDE to ensure that building equipment and systems have been installed properly and contain no identifiable defects that shorten the design life of a system or its components. Satisfactory completion of all acceptance requirements is required to obtain Government approval and acceptance of the Contractor's work.

Perform PT&I tests and provide submittals.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

2.1.1 Design Requirements

Submit the manufacturer's catalog data, including equipment and performance data, for power roof ventilator(s). As a minimum, include the following data:

- a. Fan Type
- b. Fan Specifications, including:
 - (1) Number of rotating fan blades/vanes

- (2) Number of stationary fan blades/vanes
- (3) Rotating speed(s)
- (4) Number of belts (if belt-driven)
- (5) Belt lengths- measured at the pitch line (if belt-driven)
- (6) Diameter of the drive sheave at the drive pitch line (if belt-driven)
- (7) Diameter of the driven sheave at the drive pitch line (if belt-driven)

c. Location of Installation

d. Identification Number

e. Date of Installation (Required or Actual Acceptance Date)

Submit detailed [shop drawings](#) for power roof ventilator systems.

Provide roof ventilators that comply with [UL 705](#) and are furnished complete with bases, curbs, flashing flanges, noise baffles, dampers, damper controls, louvers, and screens, as indicated.

Provide ventilators that are designed for windloads in accordance with [ASCE 7-16](#) with the installed design not less than [130 miles per hour](#) windload. Ensure that the structural bracing is properly spaced to accommodate this loading and meets the design requirements of the covering material. Ensure that ventilators are adequately reinforced and well-braced with the joints properly formed. Ensure that the edges are wired or beaded where necessary to ensure rigidity. Prevent galvanic action between different metals in direct contact by providing nonconductive separators. Make all soldering even and smooth.

Provide corrosion-resistant steel bolts, rivets, and other fastenings used in connection with protected metal.

2.2 COMPONENTS

2.2.1 [Housing](#) Style

Provide power roof ventilator as indicated.

2.2.2 [Fan](#) Type

Provide fans of the following types:

2.2.2.1 Type C-PRV Centrifugal, Direct Drive

For Type C-PRV ventilators, provide a centrifugal roof ventilator with direct drive, nonoverloading, backward-inclined wheel. Provide a vibration-isolated drive with an elastomer. Provide drive components that are mounted in a compartment isolated from the airstream.

2.2.2.2 Type CB-PRV Centrifugal, V-Belt Drive

For Type CB-PRV ventilators provide a centrifugal roof ventilator with V-belt drive, nonoverloading, backward-inclined wheel. Provide a vibration-isolated drive with an elastomer. Provide drive components that are mounted in a compartment isolated from the airstream.

2.2.2.3 Type P-PRV Propeller, Direct Drive

For Type P-PRV ventilators, provide a propeller roof ventilator with direct drive that is vibration-isolated with an elastomer. Provide drive components that are mounted in a compartment isolated from the airstream.

2.2.2.4 Type PB-PRV Propeller, V-Belt Drive

For Type PB-PRV ventilators, provide a propeller roof ventilator with V-belt drive that is vibration-isolated with an elastomer. Provide drive components that are mounted in a compartment isolated from the airstream.

2.2.2.5 Type VA-PRV Vane Axial, Direct Drive

For Type VA-PRV ventilators, provide a vane axial roof ventilator with direct drive that is vibration-isolated with an elastomer.

2.2.2.6 Type VAB-PRV Vane Axial, V-Belt Drive

For Type VAB-PRV ventilators, provide a vane axial roof ventilator with V-belt drive that is vibration-isolated with an elastomer.

2.2.2.7 Type TA-PRV Tube Axial, Direct Drive

For Type TA-PRV ventilators, provide a tube axial roof ventilator with direct drive that is vibration-isolated with an elastomer.

2.2.2.8 Type TAV-PRV Tube Axial, V-Belt Drive

For Type TAV-PRV ventilators, provide a tube axial roof ventilator with V-belt drive that is vibration-isolated with an elastomer.

2.2.3 Fan Motor

Provide single-phase, 120 V, 60 Hz, split-phase, belt-driven motors less than 1/2 horsepower, with permanently lubricated ball bearings.

Provide three-phase 208, V, 60 Hz motors 1/2 horsepower and larger.

Provide motors with local disconnects to allow for fan and motor maintenance. Provide all motors with thermal-overload protection. For motors located in airstreams, use a totally enclosed type.

Use energy efficient permanent split capacitor motors, single phase, 60 Hz direct-drive motors 1/2 horsepower or less.

2.2.4 Bases

When bases are provided with the ventilators, use factory-formed bases of the type indicated, constructed of the same material as the hoods, and of the thickness necessary to meet the design requirement for connection to the roof. Provide bases that are suitable for raised-curb mounting where

indicated. Form curb flanges of the base as cap flashing, extending at least 2 inches over the roofing base. Where indicated or required, extend the shafts of ventilators a sufficient distance through the supporting construction to permit attachment of vent ducts.

2.2.5 Roof Curbs

Provide factory-formed metal ventilator curbs of the type and design required for the ventilator and suitable for the roof configuration and flashing.

Provide job-built curbs that conform to the recommendations of the ventilator manufacturer, that are sized correctly for the ventilator, and that are suitable for the type of supporting roof construction.

2.2.6 Back-Draft Dampers

Provide gravity-operated back-draft dampers with adjustable counterweights constructed of the same material as fan housing.

2.2.7 Screens

Provide insert screens with frames constructed of the same material as that used in the ventilators and ensure the screens are securely attached in a manner that permits easy removal for access and cleaning.

2.2.8 Sound Baffles

Provide permanently constructed sound baffles that are impervious to moisture. Provide removable baffles.

2.3 MATERIALS

Provide manufacturers' standard materials.

2.3.1 Aluminum Alloy

Provide aluminum alloy in accordance with ASTM B209 and ASTM B37.

2.3.2 Zinc-Coated Steel

Provide zinc-coated steel in accordance with ASTM A653/A653M.

PART 3 EXECUTION

3.1 INSTALLATION

Submit installation drawings for power roof ventilators.

Install power roof ventilators in accordance with the manufacturer's installation instructions. Coordinate installation of ventilators with other work. Coordinate anchors, attachments, and other items to be built for installation as the work progresses. Rigidly install ventilators in a weathertight and watertight manner that is free from vibration.

3.1.1 Lubrication

Ensure the movable parts of dampers and related operating hardware are lubricated in accordance with manufacturer's printed instructions and that they operate smoothly and quietly without binding.

3.2 FIELD QUALITY CONTROL

3.2.1 Tests

Perform PT&I tests and provide submittals as specified in Section 01 86 12.07 40 RELIABILITY CENTERED ACCEPTANCE FOR MECHANICAL SYSTEMS.

After installation, test each power roof ventilator to demonstrate proper operation at indicated and specified performance requirements, including the running, balance, noise, and proper direction of fan rotation.

3.2.2 Acceptance

Prior to final acceptance, use precision alignment devices to demonstrate that the fan and motor are aligned as specified by the manufacturer.

3.3 CLOSEOUT ACTIVITIES

Submit detailed record drawings upon completion of the installation.

-- End of Section --

SECTION 23 36 00.00 40

AIR TERMINAL UNITS
08/22

PART 1 GENERAL

Section 23 30 00 HVAC AIR DISTRIBUTION applies to work specified in this section.

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AIR DUCT COUNCIL (ADC)

ADC Standards Manual (2008; 5th Edition) Flexible Duct
Performance Installation Standards

AIR-CONDITIONING, HEATING AND REFRIGERATION INSTITUTE (AHRI)

AHRI 880 I-P (2011) Performance Rating of Air Terminals

ASTM INTERNATIONAL (ASTM)

ASTM C1071 (2019) Standard Specification for Fibrous
Glass Duct Lining Insulation (Thermal and
Sound Absorbing Material)

ASTM E84 (2020) Standard Test Method for Surface
Burning Characteristics of Building
Materials

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (2023) National Electrical Code

NFPA 90A (2021) Standard for the Installation of
Air Conditioning and Ventilating Systems

UNDERWRITERS LABORATORIES (UL)

UL 486A-486B (2018; Reprint May 2021) UL Standard for
Safety Wire Connectors

1.2 ADMINISTRATIVE REQUIREMENTS

Coordinate layout and installation of air terminal units and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, communication and security systems, and partition assemblies.

1.2.1 Pre-Installation Meetings

Submit itemized lists for all materials, equipment, and fixtures to be incorporated in the work 30 days prior to commencement of work. Ensure

list includes manufacturer's style or catalog numbers, specification and drawing reference numbers, warranty information, and fabrication site information. Submit product data for each type of air terminal unit indicated, including rated capacities, furnished specialties, sound-power ratings, and accessories:

a. Bypass Single-Duct Air Terminal Units

Submit [records of existing conditions](#) consisting of the results of Contractor's survey of work area conditions and features of existing structures and facilities within and adjacent to the jobsite. Commencement of work constitutes acceptance of existing conditions.

Submit shop drawings which detail equipment assemblies and indicate dimensions, required clearances, method of field assembly, components, and location and size of each field connection. Include a schedule showing unique model designation, room location, model number, size, and accessories furnished. Include wiring diagrams to show power, signal, and control wiring.

Provide units with the configuration, capacity, and static-pressure characteristics indicated.

Ensure dimensional data stated constitutes nominal sizing, which has been adjusted by the manufacturer when necessary to accommodate acoustic material thickness.

Ensure units proposed are identical to units having at least 2 years of proven satisfactory field service.

Provide certification that units and the [list of spare parts](#) are [ADC Standards Manual](#) tested and rated.

1.3 SUBMITTALS

Government approval is required for submittals. Submit the following in accordance with Section [01 33 00](#) SUBMITTAL PROCEDURES:

[SD-01 Preconstruction Submittals](#)

[Records of Existing Conditions](#)

[SD-02 Shop Drawings](#)

[Bypass Single-Duct Air Terminal Units;](#)

[SD-03 Product Data](#)

[Bypass Single-Duct Air Terminal Units;](#)

[SD-06 Test Reports](#)

[Test Report](#)

[SD-07 Certificates](#)

[List of Spare Parts](#)

[SD-10 Operation and Maintenance Data](#)

Operation and Maintenance Manuals

SD-11 Closeout Submittals

Record Drawings

1.4 QUALITY CONTROL

Indicate on drawings the size, profiles, and dimensional requirements of air terminal units that are based on the specific system indicated.

Conform to NFPA 70, Article 100 for electrical components, devices, and accessories. List and label items as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

Ensure Air Terminals are certified under the AHRI 880 I-P Certification Program and carry the ARI Seal.

When air terminal devices are furnished with reheat coils, either integrally or remotely mounted, control panels of terminal devices shall be mounted on the same side of air terminal device as reheat coil piping connection.

PART 2 PRODUCTS

2.1 EQUIPMENT

2.1.1 Verification of Performance

Rate air terminal units according to AHRI 880 I-P.

2.1.2 Bypass Single-Duct Air Terminal Units

2.1.2.1 Configuration

Provide diverting-damper assembly inside unit casing with control components located inside a protective metal shroud.

2.1.2.2 Casing

Provide 0.034-inch steel casing. Ensure the casing includes an integral mixing baffle to efficiently mix the hot and cold airstream.

2.1.2.2.1 Casing Lining

Provide 1/2-inch thick, coated, fibrous-glass duct casing lining complying with ASTM C1071. Secure with adhesive. Cover liner with nonporous foil.

Attach a 3/4-inch thick adhesive of polyurethane foam insulation complying with UL 181 erosion requirements, and having a maximum flame-spread index of 25, and a maximum smoke-developed index of 50, for both insulation and adhesive, when tested according to ASTM E84. Coat any cut edges of fiberglass exposed to the airstream with NFPA 90A approved seal.

For the air inlet provide round stub connection for duct attachment. For the air outlet provide s-slip and drive connections. Provide removable panels for access to diverter and other parts requiring service,

adjustment, or maintenance; with airtight gasket.

2.1.2.3 Diverter Assembly

Provide galvanized-steel gate, with polyethylene linear bearings diverter assembly.

2.1.2.4 Hot-Water Heating Coil

Provide a copper tube heating coil, mechanically expanded into aluminum-plate fins. Verify heating coil passes underwater leak test to 200 psig.

2.1.2.5 Electronic Controls

Provide a 24 V damper actuator that is powered closed and powered open.

2.1.2.6 Thermostat

Provide a wall-mounting electronic type thermostat with integral control of room temperature. Ensure thermostat is time-proportional type with a reheat-coil control feature. Display temperature set-points in Celsius and Fahrenheit. Ensure the auxiliary switch energizes the heating control circuit, and changeover thermistor has a reverse action feature.

PART 3 EXECUTION

3.1 INSTALLATION

Install air terminal units level and plumb, and in accordance with NFPA 90A. Maintain sufficient clearance for normal service and maintenance.

3.1.1 Identification

Label each air terminal unit with plan number, nominal airflow, maximum and minimum factory-set airflows, coil type, and ARI certification seal.

3.1.2 Connections

Coordinate piping installations and specialty arrangements with schematics on Drawings and with requirements specified in piping systems.

Install piping adjacent to air terminal units to allow service and maintenance.

3.1.2.1 Hot-Water Piping

Connect heating coils to supply with shutoff valve, strainer, control valve, and union or flange; and to return with balancing valve and union or flange.

Connect ducts to air terminal units.

Ground units with electric heating coils.

Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

3.2 FIELD QUALITY CONTROL

Perform the following field tests and inspections and prepare a [test report](#).

After installing air terminal units and after electrical circuitry has been energized, test for compliance with requirements.

3.2.1 Leak Test

After installation, fill water coils and test for leaks. Repair leaks and retest until no leaks exist.

3.2.2 Operational Test

After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment. Remove and replace malfunctioning units and retest.

3.3 SYSTEM STARTUP

Engage a factory-authorized service representative to perform startup service.

Complete installation and startup checks according to manufacturer's written instructions and do the following:

- a. Verify that inlet duct connections are as recommended by air terminal unit manufacturer to achieve proper performance.
- b. Verify that controls and control enclosure are accessible.
- c. Verify that control connections are complete.
- d. Verify that nameplate and identification tag are visible.
- e. Verify that controls respond to inputs as specified.

3.4 CLOSEOUT ACTIVITIES

3.4.1 Operation and Maintenance

Submit 6 copies of the [operation and maintenance manuals](#) 30 calendar days prior to testing the following items. Update and re-submit data for final approval no later than 30 calendar days prior to contract completion. Concurrently, submit [record drawings](#) providing current factual information, including deviations and amendments to the drawings, and concealed and visible changes in the work.

3.4.2 Demonstration

Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air terminal units.

-- End of Section --

SECTION 23 37 13.00 40

DIFFUSERS, REGISTERS, AND GRILLES
08/22

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 113	(2013) Method of Testing for Room Air Diffusion
ASHRAE EQUIP IP HDBK	(2012) Handbook, HVAC Systems and Equipment (IP Edition)
ASHRAE FUN IP	(2021) Fundamentals Handbook, I-P Edition

1.2 ADMINISTRATIVE REQUIREMENTS

Section 23 30 00 HVAC AIR DISTRIBUTION applies to work specified in this section.

1.3 SUBMITTALS

Government approval is required for submittals. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Material, Equipment, and Fixture Lists

Records of Existing Conditions

SD-02 Shop Drawings

Fabrication Drawings

Installation Drawings

SD-03 Product Data

Equipment and Performance Data

SD-04 Samples

Manufacturer's Standard Color Chart

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

Certify air diffusion devices having been tested and rated in accordance with Chapter 19-ASHRAE EQUIP IP HDBK, Chapter 16-ASHRAE FUN IP, and ASHRAE 113, where such certification is required.

Submit equipment and performance data for air-diffusion devices consisting of sound data in terms of Noise Criteria (NC) index for the capacity range of the device.

2.2 COMPONENTS

2.2.1 Air Diffusion Device Construction

Preclude flutter, rattle, or vibration on air-diffusion device construction and mounting.

Modify devices and provide accessories necessary for mounting in indicated surface construction.

Select color from manufacturer's standard color chart which indicates the manufacturer's standard color selections and finishes for air-diffusion devices.

Provide supply diffusers with combination damper and equalizing grid. Ensure dampers are extracting-splitter type, except as otherwise indicated. Equalizing grids shall consist of individually adjustable vanes designed for equalizing airflow into diffuser neck and providing directional control of airflow.

Ensure air-diffusion device volume and pattern adjustments can be made from the face of the device. Make volume adjustments by tamper-detering device.

Provide gaskets for supply-terminal air devices mounted in finished surfaces.

Include within the material, equipment, and fixture lists the manufacturer's style or catalog numbers, specification and drawing reference numbers, warranty information, and fabrication site information.

Submit records of existing conditions consisting of the results of Contractor's survey of work area conditions and features of existing structures and facilities within and adjacent to the jobsite. Commencement of work constitutes acceptance of existing conditions.

Submit fabrication drawings for air-diffusion devices consisting of fabrication and assembly details to be performed in the factory.

2.2.2 Types of Air Diffusion Devices

2.2.2.1 Type DSA

Provide type DSA supply diffuser, square with four expanding flared members to provide radially diffused discharge air. Arrange flared members to provide a minimum of four air paths which simultaneously

diffuse air at 20 to 50 fpm. Include pattern adjustments horizontal, vertical projection, and an intermediate position or range.

Provide a baked enamel finish.

Provide integral extended surface to fit into module of lay-in ceiling.

2.2.2.2 Type GS

Provide type GS supply grilles double deflection type with adjustable face bars parallel to short dimension and adjustable rear bars parallel to long dimension.

Provide a baked enamel finish.

2.2.2.3 Type GSE

Provide type GSE series return or general exhaust grille with a square or rectangular as indicated, eggcrate face with a 1/2 by 1/2 by 1/2 inch aluminum core, white baked enamel exterior finish, black matte finish on exposed-to-view interior surface for lay-in mounting.

Provide aluminum opposed-blade damper.

.

2.2.2.4 Type RR

Provide type RR return register, single-deflection type with fixed face bars with opposed-blade dampers.

Provide registers installed in vertical surfaces with horizontal face bars set downward at approximately 45 degrees from vertical.

Provide registers installed in horizontal surfaces with face bars set straight and parallel to short dimension.

Provide a baked enamel finish.

PART 3 EXECUTION

3.1 INSTALLATION

Install equipment as indicated and specified and in accordance with manufacturer's recommendations.

Mount wall-mounted supply registers 6 inches below ceiling.

Submit [installation drawings](#) for air-diffusion devices. Indicate on drawings overall physical features, dimensions, ratings, service requirements, and equipment weights.

Unless otherwise indicated, size ductwork drop to diffusers or grilles to match unit collar sizes.

Seal connections between ductwork drops to diffusers or grilles airtight.

Support independently diffusers and grilles for T-bar mounting that exceed weight limit of ceiling suspension system in which they are to be installed.

3.1.1 Operations and Maintenance Manuals

Provide operation and maintenance manuals consistent with manufacturer's standard brochures, schematics, printed instructions, general operating procedures and safety precautions.

-- End of Section --

SECTION 23 52 00

HEATING BOILERS
04/08, CHG 5: 11/19

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL, INC. (AMCA)

AMCA 801 (2001; R 2008) Industrial Process/Power
Generation Fans: Specification Guidelines

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING
ENGINEERS (ASHRAE)

ASHRAE 52.2 (2012) Method of Testing General
Ventilation Air-Cleaning Devices for
Removal Efficiency by Particle Size

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.20.1 (2013; R 2018) Pipe Threads, General
Purpose (Inch)

ASME B16.3 (2021) Malleable Iron Threaded Fittings,
Classes 150 and 300

ASME B16.4 (2021) Gray Iron Threaded Fittings;
Classes 125 and 250

ASME B16.5 (2020) Pipe Flanges and Flanged Fittings
NPS 1/2 Through NPS 24 Metric/Inch Standard

ASME B16.9 (2018) Factory-Made Wrought Butt welding
Fittings

ASME B16.11 (2022) Forged Fittings, Socket-Welding and
Threaded

ASME B16.15 (2018) Cast Copper Alloy Threaded Fittings
Classes 125 and 250

ASME B16.18 (2021) Cast Copper Alloy Solder Joint
Pressure Fittings

ASME B16.22 (2021) Wrought Copper and Copper Alloy
Solder Joint Pressure Fittings

ASME B16.26 (2018) Standard for Cast Copper Alloy
Fittings for Flared Copper Tubes

ASME B16.34 (2021) Valves - Flanged, Threaded and

Welding End

ASME B16.39	(2020) Standard for Malleable Iron Threaded Pipe Unions; Classes 150, 250, and 300
ASME B31.1	(2022) Power Piping
ASME B31.5	(2020) Refrigeration Piping and Heat Transfer Components
ASME B40.100	(2013) Pressure Gauges and Gauge Attachments
ASME BPVC SEC IV	(2017) BPVC Section IV-Rules for Construction of Heating Boilers
ASME BPVC SEC IX	(2017; Errata 2018) BPVC Section IX-Welding, Brazing and Fusing Qualifications
ASME BPVC SEC VIII D1	(2019) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1
ASME CSD-1	(2021) Control and Safety Devices for Automatically Fired Boilers

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C606	(2015) Grooved and Shouldered Joints

AMERICAN WELDING SOCIETY (AWS)

AWS A5.8/A5.8M	(2019) Specification for Filler Metals for Brazing and Braze Welding
AWS B2.2/B2.2M	(2016) Specification for Brazing Procedure and Performance Qualification

ASTM INTERNATIONAL (ASTM)

ASTM A53/A53M	(2022) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A105/A105M	(2021) Standard Specification for Carbon Steel Forgings for Piping Applications
ASTM A167	(2011) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A183	(2014; R 2020) Standard Specification for Carbon Steel Track Bolts and Nuts
ASTM A193/A193M	(2022a) Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service and

Other Special Purpose Applications

ASTM A234/A234M	(2022) Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service
ASTM A515/A515M	(2017; R2022) Standard Specification for Pressure Vessel Plates, Carbon Steel, for Intermediate- and Higher-Temperature Service
ASTM A516/A516M	(2017) Standard Specification for Pressure Vessel Plates, Carbon Steel, for Moderate- and Lower-Temperature Service
ASTM A536	(1984; R 2019; E 2019) Standard Specification for Ductile Iron Castings
ASTM A653/A653M	(2022) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM B32	(2020) Standard Specification for Solder Metal
ASTM B62	(2017) Standard Specification for Composition Bronze or Ounce Metal Castings
ASTM B75/B75M	(2020) Standard Specification for Seamless Copper Tube
ASTM B88	(2022) Standard Specification for Seamless Copper Water Tube
ASTM B813	(2016) Standard Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube
ASTM B828	(2016) Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings
ASTM D596	(2001; R 2018) Standard Guide for Reporting Results of Analysis of Water
ASTM D2000	(2018) Standard Classification System for Rubber Products in Automotive Applications

COPPER DEVELOPMENT ASSOCIATION (CDA)

CDA A4015	(2016; 14/17) Copper Tube Handbook

HYDRONICS INSTITUTE DIVISION OF AHRI (HYI)

HYI-005	(2008) I=B=R Ratings for Boilers, Baseboard Radiation and Finned Tube (Commercial)

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS
INDUSTRY (MSS)

MSS SP-25	(2018) Standard Marking System for Valves, Fittings, Flanges and Unions
MSS SP-58	(2018) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation
MSS SP-70	(2011) Gray Iron Gate Valves, Flanged and Threaded Ends
MSS SP-71	(2018) Gray Iron Swing Check Valves, Flanged and Threaded Ends
MSS SP-72	(2010a) Ball Valves with Flanged or Butt-Welding Ends for General Service
MSS SP-78	(2011) Cast Iron Plug Valves, Flanged and Threaded Ends
MSS SP-80	(2019) Bronze Gate, Globe, Angle and Check Valves
MSS SP-85	(2011) Gray Iron Globe & Angle Valves Flanged and Threaded Ends
MSS SP-110	(2010) Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(2021) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 54	(2021) National Fuel Gas Code
NFPA 70	(2023) National Electrical Code

U.S. DEPARTMENT OF ENERGY (DOE)

Energy Star	(1992; R 2006) Energy Star Energy Efficiency Labeling System (FEMP)

UNDERWRITERS LABORATORIES (UL)

UL 1738	(2020; Reprint Aug 2021) UL Standard for Safety Venting Systems for Gas-Burning Appliances, Categories II, III and IV
UL FLAMMABLE & COMBUSTIBLE	(2012) Flammable and Combustible Liquids and Gases Equipment Directory

1.2 SUBMITTALS

Government approval is required for submittals. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Detail Drawings

SD-03 Product Data

Materials and Equipment

Spare Parts

Water Treatment System

Boiler Water Treatment

Heating System Tests

Fuel System Tests

Unit Heaters

Welding

Qualifications

Field Instructions

Tests

SD-06 Test Reports

Heating System Tests

Fuel System Tests

Water Treatment Testing

SD-07 Certificates

Bolts

SD-10 Operation and Maintenance Data

Operation and Maintenance Instructions; G

Water Treatment System; G

SD-11 Closeout Submittals

Indoor Air Quality During Construction; S

1.3 QUALITY ASSURANCE

Submit a copy of qualified welding procedures and a list of names and identification symbols of qualified welders and welding operators, at

least 2 weeks prior to the start of welding operations. Weld and braze boilers and piping in accordance with qualified procedures using performance-qualified welders and welding operators. Use procedures and welders that are qualified in accordance with [ASME BPVC SEC IX](#). Welding procedures qualified by others, and welders and welding operators qualified by another employer may be accepted as permitted by [ASME B31.1](#). Notify the Contracting Officer 24 hours in advance of tests, and perform the tests at the work site if practical. The welder or welding operator must apply the personally assigned symbol near each weld made as a permanent record. Weld structural members.

1.4 DELIVERY, STORAGE, AND HANDLING

Protect equipment delivered and placed in storage from the weather, humidity and temperature variations, dirt and dust, and other contaminants.

1.5 EXTRA MATERIALS

Submit [spare parts](#) data for each different item of material and equipment specified, after approval of the [detail drawings](#) and no later than 2 months prior to the date of beneficial occupancy. Submit Detail Drawings consisting of equipment layout including installation details and electrical connection diagrams; combustion and safety control diagrams; ductwork layout showing the location of supports and hangers, typical hanger details, gauge reinforcement, reinforcement spacing rigidity classification, and static pressure and seal classifications; and piping layout showing the location of guides and anchors, the load imposed on each support or anchor (not required for radiant floor tubing), and typical support details. Include on the drawings any information required to demonstrate that the system has been coordinated and will properly function as a unit and to show equipment relationship to other parts of the work, including clearances required for operation and maintenance. Include in the data a complete list of parts and supplies, with current unit prices and source of supply, and a list of the parts recommended by the manufacturer to be replaced after 1 and 3 years of service.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

2.1.1 Standard Products

Provide [materials and equipment](#) which are the standard products of a manufacturer regularly engaged in the manufacture of the products and that essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Provide equipment supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site. Submit manufacturer's catalog data included with the detail drawings for the following:

- a. Radiant floor heating system including tubing, joints, and manifold for radiant floor heating systems.
- b. Data showing model, size, options, etc., that are intended for consideration. Ensure data submitted is adequate to demonstrate compliance with contract requirements. Include manufacturer's written installation instructions and manufacturer's recommendations for operation and maintenance clearances for the following:

- (1) Boilers
- (2) Unit Heaters
- (3) Fuel Burning Equipment
- (4) Combustion Control Equipment
- (5) Pumps
- (6) Fittings and Accessories
- (7) Fuel Oil Storage System
- (8) Water Treatment System

2.1.2 Asbestos Prohibition

Asbestos and asbestos-containing products will not be allowed.

2.1.3 Nameplates

Secure a plate to each major component of equipment containing the manufacturer's name, address, type or style, model or serial number, and catalog number. Also, display an **Energy Star** label as applicable. Provide an approved ASME stamp for each pressure vessel.

2.1.4 Equipment Guards

Fully enclose or guard belts, pulleys, chains, gears, couplings, projecting setscrews, keys, and other rotating parts exposed to personnel contact in accordance with OSHA requirements. Properly guard high temperature equipment and piping exposed to contact by personnel or where it creates a potential fire hazard or cover with insulation of a type specified. Provide catwalks, operating platforms, ladders, and guardrails where shown and construct in accordance with Section **08 31 00 ACCESS DOORS AND PANELS**.

2.2 BOILERS

Provide each boiler with the output capacity in **British thermal units per hour (Btuh)** as indicated when fired with the specified fuels. Furnish boiler complete with the gas burning equipment, boiler fittings and trim, automatic controls, electrical wiring, insulation, piping connections, and protective jacket. Assemble boiler completely and test at the manufacturer's plant. Provide boiler auxiliaries including fans, motors, drives, and similar equipment with at least 10 percent excess capacity to allow for field variations in settings and to compensate for any unforeseen increases in pressure losses in appurtenant piping and ductwork. However, do not size the boiler safety devices for a 10 percent excess capacity. Design and install the boiler and its accessories to permit ready accessibility for operation, maintenance, and service. Design, construct, and equip boilers in accordance with **ASME BPVC SEC IV**. Each boiler must be of the condensing type and designed for water service as specified herein. Base boiler capacity on the ratings shown in **HYI-005** or as certified by the American Boiler Manufacturers Association, or American Gas Association.

2.2.1 Condensing Boiler

Provide a self-contained packaged type boiler, complete with accessories, mounted on a structural steel base or a steel base which is integral to the boiler shell. Each boiler must conform to the commercial design used by the manufacturer and permit free thermal expansion without placing undue stress on any part of the boiler. Design each boiler which

experiences the formation of condensate within the flue gas specifically for condensing application. Each boiler must withstand the corrosive effects of condensate for each part which may be in contact with the condensate at all possible operating conditions. Provide each boiler with a separate air intake, exhaust, and condensate drain. Design each boiler to withstand the water temperature differentials anticipated at the required operating conditions without experiencing any damage due to thermal shock.

2.2.2 Hot Water Heating Boilers

Provide hot water heating boiler capable of operating at the specified maximum continuous capacity without damage or deterioration to the boiler, its setting, firing equipment, or auxiliaries. The rated capacity is the capacity at which the boiler will operate continuously while maintaining at least the specified minimum efficiency. The boiler design conditions are as follows:

- a. Boiler design pressure 30 psig.
- b. Operating pressure at boiler outlet 15 psig.
- c. Hot water temperature 180 degrees F.
- d. Temperature differential between boiler discharge and system return 30 degrees F.
- e. Water pressure drop 5 psig.
- f. Outdoor ambient air temperature 110 degrees F (max), 40 degrees F (min).
- g. Site elevation 600 feet.
- h. Maximum continuous capacity 780 Btuh.
- i. Rated capacity 780 Btuh.
- j. Maximum exhaust stack temperature 30 degrees F.

2.3 FUEL BURNING EQUIPMENT

Design boiler to burn gas . Each boiler must comply with Federal, state, and local emission regulations. As a minimum, meet emission requirements:

2.3.1 Burners

2.3.2 Draft Fans

Furnish fans conforming to AMCA 801 forced-draft and induced-draft as an integral part of boiler design. Provide centrifugal fans with backward-curved blades or axial flow type. Size each fan for output volume and static pressure rating sufficient for pressure losses, excess air requirements at the burner, leakages, temperature, and elevation corrections for worst ambient conditions, all at full combustion to meet net-rated output at normal firing conditions, plus an overall excess air volume of 10 percent against a 20 percent static overpressure. Do not exceed noise levels of 85 decibels for fans in any octave band at a 3 foot

station. Design induced-draft fans for handling hot flue gas at the maximum outlet temperature in the boiler. Provide induced draft fan housings with drain holes to accommodate the drainage of condensation. Air-cool induced draft fan bearings. Provide induced draft fan scroll sheets and rotor blades with protective liners.

2.3.2.1 Draft Fan Control

Provide axial propeller fans with variable propeller pitch control.

2.3.2.2 Draft Fan Drives

Drive fans by electric motors. Electric motor must be totally enclosed fan-cooled, suitable for installation in a Class II, Division 1, Group F, hazardous location conforming to NFPA 70.

2.3.3 Ductwork

Design air ducts connecting the forced-draft fan units with the plenum chamber to convey air with a minimum of pressure loss due to friction. Provide ductwork consisting of galvanized sheet metal conforming to ASTM A653/A653M. Ducts must be straight and smooth on the inside with laps made in direction of air flow. Ducts must have cross-break with enough center height to assure rigidity in the duct section, angle iron braced, and completely free of vibration. Provide access and inspection doors as indicated and required, with a minimum of one in each section between dampers or items of equipment. Construct ducts with long radius elbows having a centerline radius 1-1/2 times the duct width, or where the space does not permit the use of long radius elbows, short radius or square elbows with factory-fabricated turning vanes may be used. Duct joints must be substantially airtight and have adequate strength for the service, with 1-1/2 x 1-1/2 x 1/8 inch angles used where required for strength or rigidity. Provide duct wall thickness of 16 gauge (0.0598 inch) for ducts 60 inches or less and 12 gauge (0.1046 inch) for ducts larger than 60 inches in maximum dimension. Additional ductwork must be in accordance with Section 23 30 00 HVAC AIR DISTRIBUTION.

2.4 COMBUSTION CONTROL EQUIPMENT

Provide combustion control equipment as a system by a single manufacturer. Field install automatic combustion control system in accordance with the manufacturer's recommendations and under the direct supervision of a representative of the control manufacturer. Control the boiler water temperature by a water temperature controller. Operate the equipment electronically. On multiple boiler installations, provide each boiler unit with a completely independent system of controls responding to the load and to a plant master controller. If recording instruments are provided, furnish a 1 year supply of ink and 400 blank charts for each recorder.

2.4.1 Boiler Plant Master Controller

Furnish a boiler plant master controller, sensitive to a temperature transmitter in the return water header for the boiler to provide anticipatory signals to all boiler controllers. Boiler controllers must react to anticipatory signals from the plant master controller as necessary in response to the boiler temperature indication to maintain the preset temperature. Provide an automatic-manual switch to allow the sequence of boiler loading to be varied to distribute equal firing time on

all boilers in the plant. The plant master controller must load the boilers one at a time as the plant load increases.

2.4.2 Boiler Combustion Controls and Positioners

- a. Provide gas boiler units with modulating combustion controls with gas pilot or spark ignition. Provide modulating controls with a means for manually controlling the firing rate.
- b. Fixed rate on-off controls for boilers with capacities up to 2,000,000 Btuh must use a water temperature controller in a temperature well in direct contact with the water .

2.4.3 Combustion Safety Controls and Equipment

Provide combustion safety controls and equipment that are UL listed, microprocessor-based distributed process controller. Include mounting hardware, wiring and cables, and associated equipment. Mount completely wired, programmed, debugged controller, and test to perform all of its functions. Process the signals for complete control and monitoring of the boiler. This includes maintaining boiler status, starting and stopping all control functions, sequencing control functions and signaling alarm conditions. Document the program and include cross references in description of coils and contacts. Provide microprocessor to perform self diagnostics and contain a message center to provide operator with status and failure mode information. Mount controllers for each boiler on a separate, free standing panel adjacent to the boiler or for packaged boilers on the boiler supporting structure. Provide control systems and safety devices for automatically fired boilers conforming to ASME CSD-1. Provide electrical combustion and safety controls rated at 120 volts, single phase, 60 Hz and connect as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Provide a 4 inch diameter alarm bell and locate where indicated or directed. The alarm bell must ring when the boiler is shut down by any safety control or interlock. Provide indicating lights on the control panel. Use a red light to indicate flame failure, and a green light to indicate that the main fuel valve is open. The following shutdown conditions require a manual reset before the boiler can automatically recycle:

- a. Flame failure.
- b. Failure to establish pilot flame.
- c. Failure to establish main flame.
- d. Low-water cutoff.
- e. High pressure cutoff.

2.4.3.1 Low-water Cutoff

Provide float actuated switch or electrically actuated probe type low-water cutoff. Provide float chamber with a blow-down connection. Cutoff must cause a safety shutdown and sound an alarm when the boiler water level drops below a safe minimum level. A safety shutdown due to low water must require manual reset before operation can be resumed and prevent recycling of the burner. The cutoff must be in strict accordance

to ASME CSD-1.

2.4.3.1.1 Pump Controller with Low-Water Cutoff

Provide controller of a design approved by the boiler manufacturer. Provide a pump controller for each boiler which is used for space heating and process steam loads or long distribution lines. Control the operation of the burner, forced-draft fan, and pump. Provide pump controller and low-water cutoff with a float-operated mercury switch arranged to start and stop the pump at preset boiler water levels. If the water level in the boiler reaches the low danger point, provide a second mercury switch to shut down the burner and actuate the alarm bell.

2.4.3.2 Water Flow Interlock

Provide hot water boiler limit controls to include protection for low boiler water flow and high boiler water temperature. Interlock the limit controls with the combustion control system to effect boiler alarm and shutdown. Do not allow boiler startup unless hot water flow is proven.

2.5 PUMPS

2.5.1 Hot Water and Boiler Circulating Pumps

Provide circulating pumps for hot water that are electrically driven single-stage centrifugal type and have a capacity no less than indicated. Support boiler circulating pumps by the piping on which installed and must be flexible-coupled shaft. The boiler circulating pumps must be incline type. . Construct pump shaft of corrosion-resistant alloy steel, sleeve bearings and glands of bronze designed to accommodate a mechanical seal, and the housing of close-grained cast iron. Use pump seals capable of withstanding 240 degrees F temperature without external cooling. Provide motor with sufficient power for the service required, of a type approved by the manufacturer of the pump, suitable for the available electric service, and conforming to the requirements of paragraph ELECTRICAL EQUIPMENT. Provide each pump suction and discharge connection with a pressure gauge as specified. Provide the boiler circulating pump discharge heater with a flow switch .

2.6 UNIT HEATERS

Provide heaters as specified below, and with a heating capacity not in excess of 125 percent of the capacity indicated.

2.6.1 Propeller Fan Heaters

Design heaters for suspension and arrange for horizontal discharge of air as indicated. Provide casings consisting of no less than 20 gauge black steel and finished with lacquer or enamel. Provide suitable stationary deflectors to assure proper air and heat penetration capacity at floor level based on established design temperature. Suspension from heating pipes will not be permitted. Operate fans for vertical discharge type heaters at speeds not in excess of 1,200 rpm, except that units with 80,000 Btu output capacity or less may operate at speeds up to 1,800 rpm. Provide horizontal discharge type unit heaters with discharge or face velocities not in excess of the following:

Unit Capacity, cfm	Face Velocity, fpm
Up to 1000	800
1,001 to 3,000	900
3001 and over	1,000

2.6.2 Heating Elements

Provide heating coils as specified in Section 23 30 00 HVAC AIR DISTRIBUTION for types indicated. Ensure coils are suitable for use with water up to 250 degrees F.

2.6.3 Motors

Provide motors with NEMA MG 1 open drip proof (ODP) enclosure. Motors and motor controls must otherwise be as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

2.6.4 Motor Switches

Provide motors with manual selection switches with "Off," and "Automatic" positions and equip with thermal overload protection.

2.6.5 Controls

Provide controls as specified in Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.

2.7 HEATING AND VENTILATING UNITS

Provide heating and ventilating units and associated equipment in accordance with Section 23 30 00 HVAC AIR DISTRIBUTION.

2.8 AIR HANDLING UNITS

Provide air handling units and associated equipment in accordance with Section 23 30 00 HVAC AIR DISTRIBUTION.

2.9 FITTINGS AND ACCESSORIES

Install boiler fittings and accessories with each boiler in accordance with ASME BPVC SEC IV, unless otherwise specified.

2.9.1 Conventional Breeching and Stacks

2.9.2 Direct Vents

Use direct venting for condensing type boilers. Size and locate the air intake and exhaust vents as indicated on the drawings and as recommended by the boiler manufacturer. Provide a separate combustion air intake vent and exhaust vent for each boiler.

2.9.2.1 Exhaust Vent

Construct the exhaust vent piping of Schedule 40 CPVC or stainless steel

conforming to [UL 1738](#) and the boiler manufacturer's recommendations. Plastic materials polyetherimide (PEI) and polyethersulfone (PES) are forbidden to be used for vent piping of combustion gases. Provide exhaust vent that is suitable for the maximum anticipated boiler exhaust temperature and withstands the corrosive effects of the condensate. Provide a [0.3125 inch](#) diameter hole in the stack no greater than [6 inches](#) from the boiler flue outlet for sampling of the exit gases. Provide a method to seal the hole to prevent exhaust gases from entering the boiler room when samples are not being taken. Provide each exhaust stack complete with bird screen.

2.9.3 Expansion Tank

Provide hot water pressurization system including a diaphragm-type expansion tank which will accommodate the expanded water of the system generated within the normal operating temperature range, limiting the pressure increase at all components in the system to the maximum allowable pressure at those components. The only air in the system will be the permanent sealed-in air cushion contained in the diaphragm-type tank. Provide sizes as indicated. Provide welded steel expansion tank, constructed, tested, and stamped in accordance with [ASME BPVC SEC VIII D1](#) for a working pressure of [125 psi](#) and precharged to the minimum operating pressure. Fit the tank's air chamber with an air charging valve and pressure gauge. Support the tank by steel legs or bases for vertical installation or steel saddles for horizontal installations. Provide lifting rings and a drain connection for the tank. All components must be suitable for a maximum operating temperature of [250 degrees F](#).

2.9.4 Air Separator

Provide steel external air separation tank, constructed, tested and stamped in accordance with [ASME BPVC SEC VIII D1](#) for a working pressure of [125 psi](#). The capacity of the air separation tank indicated is minimum.

2.9.5 Filters

Provide filters conforming to [ASHRAE 52.2](#).

2.9.6 Steel Pipe and Fittings

2.9.6.1 Steel Pipe

Steel pipe must be [ASTM A53/A53M](#), Type E or S, Grade A or B, black steel, standard weight.

2.9.6.2 Steel Pipe Fittings

Affix the manufacturer's trademark to fittings in accordance with [MSS SP-25](#) to permanently identify the manufacturer.

2.9.6.3 Steel Flanges

Provide flanged fittings including items such as flanges, bolts, nuts, bolt patterns, in accordance with [ASME B16.5](#) class 150 and have the manufacturer's trademark affixed in accordance with [MSS SP-25](#). Provide flange material conforming to [ASTM A105/A105M](#). Use serrated or raised-face type flanges for high temperature water systems. Provide blind flange material conforming to [ASTM A516/A516M](#) cold service and [ASTM A515/A515M](#) for hot service. Provide high strength or intermediate

strength bolts with material conforming to ASTM A193/A193M. Submit written certification by the bolt manufacturer that the bolts furnished comply with the requirements of this specification. Include illustrations of product markings, the date of manufacture, and the number of each type of bolt to be furnished based on this certification.

2.9.6.4 Welded Fittings

Provide welded fittings conforming to ASTM A234/A234M with WPA marking. Provide buttwelded fittings conforming to ASME B16.9, and socket-welded fittings conforming to ASME B16.11.

2.9.6.5 Cast-Iron Fittings

Provide ASME B16.4, Class 125, type fittings required to match connecting piping.

2.9.6.6 Malleable-Iron Fittings

Provide ASME B16.3, type fittings as required to match connecting piping.

2.9.6.7 Unions

Provide ASME B16.39, Class 150 unions.

2.9.6.8 Threads

Provide pipe threads conforming to ASME B1.20.1.

2.9.6.9 Grooved Mechanical fittings

Design joints and fittings for no less than 125 psig service, and ensure joints and fittings are the products of the same manufacturer. Provide ductile iron fitting and coupling houses conforming to ASTM A536. Provide molded synthetic rubber gaskets with central cavity, pressure responsive configuration and conforming to ASTM D2000 for circulating medium up to 230 degrees F. Provide grooved joints conforming to AWWA C606. Provide steel coupling nuts and bolts conforming to ASTM A183.

2.9.7 Copper Tubing and Fittings

2.9.7.1 Copper Tubing

Provide ASTM B88, Type K or L tubing. Use brass or bronze adapters for copper tubing for brazed fittings.

2.9.7.2 Solder-Joint Pressure Fittings

Provide wrought copper and bronze solder-joint pressure fittings conforming to ASME B16.22 and ASTM B75/B75M. Provide cast copper alloy solder-joint pressure fittings conforming to ASME B16.18 and ASTM B828.

2.9.7.3 Flared Fittings

Provide cast copper alloy fittings for flared copper tube conforming to ASME B16.26 and ASTM B62.

2.9.7.4 Adapters

Adapters may be used for connecting tubing to flanges and to threaded ends of valves and equipment. Extracted brazed tee joints produced with an acceptable tool and installed as recommended by the manufacturer may be used.

2.9.7.5 Threaded Fittings

Provide cast bronze threaded fittings conforming to [ASME B16.15](#).

2.9.7.6 Brazing Material

Use brazing material conforming to [AWS A5.8/A5.8M](#).

2.9.7.7 Brazing Flux

Provide paste or liquid form flux appropriate for use with brazing material. Flux must be as follows: lead-free; have a 100 percent flushable residue; contain slightly acidic reagents; contain potassium borides, and contain fluorides. Use silver brazing materials in accordance with [AWS A5.8/A5.8M](#).

2.9.7.8 Solder Material

Provide solder metal conforming to [ASTM B32](#) 95-5 tin-antimony.

2.9.7.9 Solder Flux

Flux must be either liquid or paste form, non-corrosive and conform to [ASTM B813](#).

2.9.7.10 Grooved Mechanical Fittings

Design joints and fittings for no less than [125 psig](#) service, and ensure joints and fittings are the products of the same manufacturer. Provide ductile iron fitting and coupling houses conforming to [ASTM A536](#). Provide molded synthetic rubber gaskets with central cavity, pressure responsible configuration and conforming to [ASTM D2000](#), for circulating medium up to [230 degrees F](#). Provide grooved joints conforming to [AWWA C606](#). Provide steel coupling nuts and bolts conforming to [ASTM A183](#).

2.9.8 Dielectric Waterways and Flanges

Provide dielectric waterways that have temperature and pressure rating equal to or greater than that specified for the connecting piping. Provide waterways with metal connections on both ends suited to match connecting piping. Include dielectric unions to prevent current flow between dissimilar metals. Use dielectric flanges meeting the performance requirements described herein for dielectric waterways.

2.9.9 Flexible Pipe Connectors

Design flexible pipe connectors for [125 psi](#) or [150 psi](#) service. Install connectors where indicated. Construct the flexible section of rubber, tetrafluoroethylene resin, or corrosion-resisting steel, bronze, monel, or galvanized steel. Use materials and configuration suitable for the pressure, vacuum, and temperature medium. The flexible section must be suitable for service intended and may have threaded, welded, soldered,

flanged, or socket ends. Equip flanged assemblies with limit bolts to restrict maximum travel to the manufacturer's standard limits. Unless otherwise indicated, the length of the flexible connectors must be as recommended by the manufacturer for the service intended. Provide internal sleeves or liners, compatible with circulating medium, when recommended by the manufacturer. Provide covers to protect the bellows where indicated.

2.9.10 Pipe Supports

Provide pipe supports conforming to [MSS SP-58](#).

2.9.11 Pipe Expansion

2.9.11.1 Expansion Loops

Expansion loops and offsets must provide adequate expansion of the main straight runs of the system within the stress limits specified in [ASME B31.1](#). Provide cold-sprung loops and offsets and install where indicated. Provide pipe guides and anchors as indicated.

2.9.12 Valves

Provide Class 125 valves that are suitable for the application. Grooved ends in accordance with [AWWA C606](#) may be used for water service only. Provide valves in nonboiler external piping meeting the material, fabrication and operating requirements of [ASME B31.1](#). The connection type of all valves must match the same type of connection required for the piping on which installed.

2.9.12.1 Gate Valves

Provide gate valves [2-1/2 inches](#) and smaller conforming to [MSS SP-80](#) bronze rising stem, threaded, solder, or flanged ends. Provide gate valves [3 inches](#) and larger conforming to [MSS SP-70](#) cast iron bronze trim, outside screw and yoke, flanged, or threaded ends.

2.9.12.2 Globe Valves

Provide globe valves [2-1/2 inches](#) and smaller conforming to [MSS SP-80](#), bronze, threaded, soldered, or flanged ends. Provide globe valves [3 inches](#) and larger conforming to [MSS SP-85](#), cast iron, bronze trim, flanged, or threaded ends.

2.9.12.3 Check Valves

Provide check valves [2-1/2 inches](#) and smaller conforming to [MSS SP-80](#), bronze, threaded, soldered, or flanged ends. Provide check valves [3 inches](#) and larger conforming to [MSS SP-71](#), cast iron, bronze trim, flanged, or threaded ends.

2.9.12.4 Angle Valves

Provide angle valves [2-1/2 inches](#) and smaller conforming to [MSS SP-80](#) bronze, threaded, soldered, or flanged ends. Provide angle valves [3 inches](#) and larger conforming to [MSS SP-85](#), cast iron, bronze trim, flanged, or threaded ends.

2.9.12.5 Ball Valves

Provide ball valves **1/2 inch** and larger conforming to **MSS SP-72** or **MSS SP-110**, ductile iron or bronze, threaded, soldered, or flanged ends.

2.9.12.6 Plug Valves

Provide plug valves **2 inch** and larger conforming to **MSS SP-78**. Provide plug valves smaller than **2 inch** conforming to **ASME B16.34**.

2.9.12.7 Grooved End Valves

Valves with grooved ends in accordance with **AWWA C606** may be used if the valve manufacturer certifies that their performance meets the requirements of the standards indicated for each type of valve.

2.9.12.8 Balancing Valves

Provide balancing valves that have meter connections with positive shutoff valves. Provide an integral pointer to register the degree of valve opening. Calibrate valves so that flow rate can be determined when valve opening in degrees and pressure differential across valve is known. Construct each balancing valve with internal seals to prevent leakage and supply with preformed insulation. Provide valves that are suitable for **250 degrees F** temperature and working pressure of the pipe in which installed. Provide valve bodies with tapped openings and pipe extensions with shutoff valves outside of pipe insulation. Provide pipe extensions with quick connecting hose fittings for a portable meter to measure the pressure differential. Furnish one portable differential meter. Provide meter suitable for the operating pressure specified complete with hoses, vent, and shutoff valves, and carrying case. In lieu of the balancing valve with integral metering connections, a ball valve or plug valve with a separately installed orifice plate or venturi tube may be used for balancing.

2.9.12.9 Butterfly Valves

Provide 2-flange type or lug wafer type butterfly valves, and make bubbletight at **150 psig**. Provide valve bodies consisting of cast iron, malleable iron, or steel. Provide **ASTM A167**, Type 404 or Type 316, corrosion resisting steel stems, bronze, or corrosion resisting steel discs, and synthetic rubber seats. Valves smaller than **8 inches** must have throttling handles with a minimum of seven locking positions. Valves **8 inches** and larger must have totally enclosed manual gear operators with adjustable balance return stops and position indicators. Provide valves in insulated lines with extended neck to accommodate insulation thickness.

2.9.12.10 Drain valves

Provide drain valves at each drain point of blowdown as recommended by the boiler manufacturer. Provide piping conforming to **ASME BPVC SEC IV** and **ASTM A53/A53M**.

2.9.12.11 Safety Valves

Provide safety valves with steel bodies and equip with corrosion-resistant trim and valve seats. The valves must be properly guided and positive closing so that no leakage can occur. Adjustment of the desired back-pressure must cover the range between **2 and 10 psig**. Make the

adjustment externally, and provide any shafts extending through the valve body with adjustable stuffing boxes having renewable packing. Install boiler safety valves of proper size and of the required number, in accordance with **ASME BPVC SEC IV**, so that the discharge will be through piping extended to a location as indicated.

2.9.13 Strainers

Provide basket and "Y" type strainers which are the same size as the pipelines in which they are installed. Provide strainer bodies that are heavy and durable, fabricated of cast iron, and drill and tap bottoms with a gate valve attached for blowdown purposes. Design strainers for **100 psig** service and **180 degrees F**. Clearly cast arrows on the sides of bodies indicating the direction of flow. Equip each strainer with an easily removable cover and sediment screen. Make the screen of **22 gauge** thick brass sheet with small perforations numbering not less than **400/square inch** to provide a net free area through the basket of at least 3.30 times that of the entering pipe. The flow must be into the screen and out through the perforations.

2.9.14 Pressure Gauges

Provide gauges conforming to **ASME B40.100** with throttling type needle valve or a pulsation dampener and shutoff valve. Provide minimum dial size of **3-1/2 inches**. Provide a pressure gauge for each boiler in a visible location on the boiler. Provide pressure gauges with readings in **psi**. Provide pressure gauges with an indicating pressure range that is related to the operating pressure of the fluid in accordance with the following table:

Operating Pressure (psi)	Pressure Range (psi)
76-150	0-200
16-75	0-100
2-15	0-30 (retard)

2.9.15 Thermometers

Provide thermometers with wells and separable corrosion-resistant steel sockets. Do not use mercury in thermometers. Provide thermometers for inlet water and outlet water for each hot water boiler in a visible location on the boiler. Provide thermometers with brass, malleable iron, or aluminum alloy case and frame, clear protective face, permanently stabilized glass tube with indicating-fluid column, white face, black numbers, and a minimum **9 inch** scale. The operating range of the thermometers must be **32-212 degrees F**. Provide thermometers with readings in degrees F.

2.9.16 Air Vents

2.9.16.1 Manual Air Vents

Manual air vents must be brass or bronze valves or cocks suitable for the pressure rating of the piping system and furnished with threaded plugs or caps.

2.9.16.2 Automatic Air Vents

Automatic air vents must be 3/4 inch quick-venting float and vacuum air valves. Provide each air vent valve with a large port permitting the expulsion of the air without developing excessive back pressure, a noncollapsible metal float which will close the valve and prevent the loss of water from the system, an air seal that will effectively close and prevent the re-entry of air into the system when subatmospheric pressures prevail therein, and a thermostatic member that will close the port against the passage of steam from the system. Clearly stamp the name of the manufacturer on the outside of each valve. Ensure the air vent valve is suitable for the pressure rating of the piping system.

2.10 ELECTRICAL EQUIPMENT

Provide electric motor-driven equipment complete with motors, motor starters, and necessary control devices. Provide electrical equipment, motor control devices, motor efficiencies and wiring as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Ensure motors which are not an integral part of a packaged boiler and which are integral in size are the premium efficiency type in accordance with NEMA MG 1. Ensure motors which are an integral part of the packaged boiler are the highest efficiency available by the manufacturer of the packaged boiler. Provide motor starters complete with properly sized thermal overload protections and other appurtenances necessary for the motor control specified. Furnish starters in watertight enclosures. Provide manual or automatic control and protective or signal devices required for the operation specified and any control wiring required for controls and devices that are not shown.

2.10.1 Motor Ratings

Motors must be suitable for the voltage and frequency provided. Motors 1/2 hp and larger must be three-phase, unless otherwise indicated. Provide motors of sufficient capacity to drive the equipment at the specified capacity without exceeding the nameplate rating on the motor.

2.10.2 Motor Controls

Provide motor controllers complete with properly sized thermal overload protection. Provide manual or automatic control and protective or signal devices required for the operation specified and any wiring required to such devices. Where two-speed or variable-speed motors are indicated, solid-state variable-speed controllers may be provided to accomplish the same function. Utilize solid state variable speed controllers for fractional through 10 hp ratings. Use adjustable frequency drives for larger motors.

2.11 INSULATION

Use shop and field-applied insulation as specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

2.12 TOOLS

Furnish special tools. Include uncommon tools necessary for the operation and maintenance of boilers, burners, pumps, fans, controls, meters, special piping systems, and other equipment. Furnish small hand tools

within a suitable cabinet, mounted where directed.

2.13 BOILER WATER TREATMENT

Submit six complete copies of the proposed water treatment plan. Include a layout, control scheme, a list of the existing water conditions including the items listed in this paragraph, a list of all chemicals, the proportion of chemicals to be added, the final treated water conditions, and a description of environmental concerns for handling the chemicals. The **water treatment system** must be capable of feeding chemicals and bleeding the system to prevent corrosion and scale within the boiler and piping distribution system. Submit 6 complete copies of operating and maintenance manuals for the step-by-step water treatment procedures, including procedures for testing the water quality. Treat the water to maintain the conditions recommended by the boiler manufacturer. Provide chemicals meeting required federal, state, and local environmental regulations for the treatment of boilers and discharge to the sanitary sewer. Use the services of a company regularly engaged in the treatment of boilers to determine the correct chemicals and concentrations required for water treatment. The company must maintain the chemical treatment and provide all chemicals required for a period of 1 year from the date of occupancy. Do not use filming amines and proprietary chemicals. The water treatment chemicals must remain stable throughout the operating temperature range of the system and must be compatible with pump seals and other elements of the system.

2.13.1 Boiler Water Limits

Consult the boiler manufacturer for the determination of the boiler water chemical composition limits.

2.13.2 Chemical Shot Feeder

Provide a shot feeder as indicated. Base size and capacity of feeder upon local requirements and water analysis. Furnish the feeder with an air vent, gauge glass, funnel, valves, fittings, and piping.

2.13.3 Test Kits

Provide one test kit of each type required to determine the water quality as outlined within the operation and maintenance manuals.

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with details of the work, verify dimensions in the field, and advise the Contracting Officer of any discrepancy before performing any work or ordering any materials.

3.2 ERECTION OF BOILER AND AUXILIARY EQUIPMENT

Install boiler and auxiliary equipment in accordance with manufacturer's written instructions. Make proper provision for expansion and contraction between boiler foundation and floor. Pack this joint with suitable nonasbestos rope and fill with suitable compound that will not become soft at a temperature of **100 degrees F**. Support boilers and firing equipment from the foundations by structural steel completely independent of all

brickwork. Boiler supports must permit free expansion and contraction of each portion of the boiler without placing undue stress on any part of the boiler or setting. Boiler breeching must be as indicated with full provision for expansion and contraction between all interconnected components.

3.3 PIPING INSTALLATION

Unless otherwise specified, provide nonboiler external pipe and fittings conforming to the requirements of [ASME B31.1](#). Cut pipe accurately to suit field conditions, install without springing or forcing, and properly clearing windows, doors, and other openings. Cutting or other weakening of the building structure to facilitate piping installation will not be permitted. Provide pipes that are free of burrs, oil, grease and other foreign material and install to permit free expansion and contraction without damaging the building structure, pipe, pipe joints, or pipe supports. Make changes in direction with fittings, except that bending of pipe [4 inches](#) and smaller will be permitted provided a pipe bender is used and wide sweep bends are formed. The centerline radius of bends must not be less than 6 diameters of the pipe. Bent pipe showing kinks, wrinkles, flattening, or other malformations will not be accepted. Carry vent pipes through the roof as directed and flash properly. Unless otherwise indicated, pitch horizontal supply mains down in the direction of flow with a grade of no less than [1 inch in 40 feet](#). Properly cap or plug open ends of pipelines and equipment during installation to keep dirt or other foreign materials out of the systems. Pipe not otherwise specified must be uncoated. Unless otherwise specified or shown, make final connections to equipment with malleable-iron unions for steel pipe [2-1/2 inches](#) or less in diameter and with flanges for pipe [3 inches](#) or more in diameter. Provide brass or bronze unions for copper pipe or tubing. Use reducing fittings for changes in pipe sizes. In horizontal hot water lines, use eccentric type reducing fittings to maintain the top of the lines at the same level to prevent air binding.

3.3.1 Hot Water Piping and Fittings

Pipe must be black steel or copper tubing. Fittings for steel piping must be black malleable iron or cast iron to suit piping. Fittings adjacent to valves must suit valve material. Grooved mechanical fittings will not be allowed for water temperatures above [230 degrees F](#).

3.3.2 Vent Piping and Fittings

Provide black steel vent piping. Fittings must be black malleable iron or cast iron to suit piping.

3.3.3 Gauge Piping

Piping must be copper tubing.

3.3.4 Joints

Provide threaded, grooved, flanged or welded joints between sections of steel pipe and between steel pipe and fittings as indicated or specified. Except as otherwise specified, fittings [1 inch](#) and smaller must be threaded; fittings [1-1/4 inches](#) and up to but not including [3 inches](#) must be either threaded, grooved, or welded; and fittings [3 inches](#) and larger must be either flanged, grooved, or welded. Weld pipe and fittings [1-1/4 inches](#) and larger installed in inaccessible conduit or trenches beneath

concrete floor slabs. Make connections to equipment with black malleable-iron unions for pipe 2-1/2 inches or smaller in diameter and with flanges for pipe 3 inches or larger in diameter. Provide flared, soldered, or brazed joints between sections of copper tubing or pipe.

3.3.4.1 Threaded Joints

Make threaded joints with tapered threads properly cut and make perfectly tight with a stiff mixture of graphite and oil or with polytetrafluoroethylene tape applied to the male threads only and in no case to the fittings.

3.3.4.2 Welded Joints

Weld joints in accordance with paragraph GENERAL REQUIREMENTS unless otherwise specified. Make changes in direction of piping with welding fittings only; mitering or notching pipe to form elbows and tees or other similar type construction will not be permitted. Branch connections may be made with either welding tees or forged branch outlet fittings, either being acceptable without size limitation. Branch outlet fittings, where used, must be forged, flared for improved flow characteristics where attached to the run, reinforced against external strains, and designed to withstand full pipe bursting strength. Assemble socket weld joints so that the space between the end of the pipe and the bottom of the socket is no less than 1/16 inch and no more than 1/8 inch.

3.3.4.3 Grooved Mechanical Joints

Grooved mechanical joints may be provided for hot water systems in lieu of unions, welded, flanged, or screwed piping connections in low temperature hot water systems where the temperature of the circulating medium does not exceed 230 degrees F. Prepare grooves according to the coupling manufacturer's instructions. Use pipe and groove dimensions in compliance with the tolerances specified by the coupling manufacturer. Measure the diameter of grooves made in the field using a "go/no-go" gauge, vernier or dial caliper, narrow-land micrometer or other method specifically approved by the coupling manufacturer for the intended application. Measure and record groove width and dimension of groove from end of pipe for each change in grooving tool setup to verify compliance with coupling manufacturer's tolerances. Do not use grooved joints in concealed locations. Mechanical joints must use rigid mechanical pipe couplings, except at equipment connections. At equipment connections, flexible couplings may be used. Provide bolted type coupling for use with grooved end pipes, fittings, valves, and strainers. Provide self-centering couplings that engage in a watertight couple.

3.3.4.4 Flared and Brazed Copper Pipe and Tubing

Cut tubing square, and remove burrs. Clean both inside of fittings and outside of tubing thoroughly with sand cloth or steel wire brush before brazing. Annealing of fittings and hard-drawn tubing must not occur when making connections. Install in accordance with the manufacturer's recommendations. Mitering of joints for elbows and notching of straight runs of pipe for tees will not be permitted. Make brazed joints in conformance with AWS B2.2/B2.2M and CDA A4015 with flux. Copper-to-copper joints must include the use of copper-phosphorous or copper-phosphorous-silver brazing metal without flux. Brazing of dissimilar metals (copper to bronze or brass) must include the use of flux with either a copper-phosphorous, copper-phosphorous-silver or a silver

brazing filler metal. Joints for flared fittings must be of the compression pattern. Provide swing joints or offsets in all branch connections, mains, and risers to provide for expansion and contraction forces without undue stress to the fittings or to short lengths of pipe or tubing. Provide flared or brazed copper tubing to pipe adapters where necessary for joining threaded pipe to copper tubing.

3.3.4.5 Soldered Joints

Make soldered joints with flux and are only acceptable for lines 2 inches and smaller. Provide soldered joints conforming to ASME B31.5 and CDA A4015.

3.3.4.6 Copper Tube Extracted Joint

An extruded mechanical tee joint may be made in copper tube. Produce joint with an appropriate tool by drilling a pilot hole and drawing out the tube surface to form a collar having a minimum height of three times the thickness of the tube wall. To prevent the branch tube from being inserted beyond the depth of the extracted joint, provide dimpled depth stops. Notch the branch tube for proper penetration into fitting to assure a free flow joint. Braze extracted joints using a copper phosphorous classification brazing filler metal. Soldered joints will not be permitted.

3.3.5 Flanges and Unions

Provide faced true flanges with 1/16 inch thick gaskets, and make square and tight. Where steel flanges mate with cast-iron flanged fittings, valves, or equipment, provide flanges with flat faces and full face gaskets. Provide union or flange joints in each line immediately preceding the connection to each piece of equipment or material requiring maintenance such as coils, pumps, control valves, and other similar items. Provide dielectric pipe unions between ferrous and nonferrous piping to prevent galvanic corrosion. Use dielectric unions with metal connections on both ends. The ends must be threaded, flanged, or brazed to match adjacent piping. Separate the metal parts of the union so that the electrical current is below 1 percent of the galvanic current which would exist upon metal-to-metal contact. Install gaskets, flanges, and unions in accordance with manufacturer's recommendations.

3.3.6 Branch Connections

3.3.6.1 Branch Connections for Hot Water Systems

Pitch branches from the main up or down as shown to prevent air entrapment. Connections must ensure unrestricted circulation, eliminate air pockets, and permit complete drainage of the system. Pitch branches with a grade of no less than 1 inch in 10 feet. When indicated, install special flow fittings on the mains to bypass portions of the water through each radiator. Use special flow fittings that are standard catalog products and install as recommended by the manufacturer.

3.3.7 Flared, Brazed, and Soldered Copper Pipe and Tubing

Provide flared, brazed, or soldered copper tubing. Cut tubing square, and remove burrs. Clean both inside of fittings and outside of tubing thoroughly with sand cloth or steel wire brush before brazing. Annealing of fittings and hard-drawn tubing must not occur when making connections.

Install in accordance with the manufacturer's recommendations. Mitering of joints for elbows and notching of straight runs of pipe for tees will not be permitted. Joints for flared fittings must be of the compression pattern. Provide swing joints or offsets on branch connections, mains, and risers to provide for expansion and contraction forces without undue stress to the fittings or to short lengths of pipe or tubing. Provide pipe adapters where necessary for joining threaded pipe to copper tubing. Make brazed joints in conformance with [CDA A4015](#). Copper-to-copper joints must include the use of copper-phosphorous or copper-phosphorous-silver brazing metal without flux. Brazing of dissimilar metals (copper to bronze or brass) must include the use of flux with either a copper-phosphorous, copper-phosphorous-silver, or a silver brazing filler metal. Make soldered joints with flux and are only acceptable for lines [2 inches](#) or smaller. Provide soldered joints conforming to [ASME B31.5](#) and in accordance with [CDA A4015](#).

3.3.8 Copper Tube Extracted Joint

An extracted mechanical tee joint may be made in copper tube. Produce joint with an appropriate tool by drilling a pilot hole and drawing out the tube surface to form a collar having a minimum height of three times the thickness of the tube wall. To prevent the branch tube from being inserted beyond the depth of the extracted joint, provide dimpled depth stops. Notch the branch tube for proper penetration into fitting to assure a free flow joint. Braze extracted joints using a copper phosphorous classification brazing filler metal. Soldered joints will not be permitted.

3.3.9 Supports

Fabricate hangers used to support piping [2 inches](#) and larger to permit adequate adjustment after erection while still supporting the load. Install pipe guides and anchors to keep pipes in accurate alignment, to direct the expansion movement, and to prevent buckling, swaying, and undue strain. Support piping subjected to vertical movement when operating temperatures exceed ambient temperatures by variable spring hangers and supports or by constant support hangers. Do not use formed or bent threaded rods for support. Do not attach supports to the underside of concrete filled floors or concrete roof decks unless approved by the Contracting Officer.

3.3.9.1 Pipe Hangers, Inserts, and Supports

Provide pipe hangers, inserts, and supports conforming to [MSS SP-58](#), except as modified herein.

3.3.9.1.1 Types 5, 12, and 26

Use of Types 5, 12, and 26 is prohibited.

3.3.9.1.2 Type 3

Do not use Type 3 on insulated pipe which has a vapor barrier. Type 3 may be used on insulated pipe that does not have a vapor barrier if clamped directly to the pipe, if the clamp bottom does not extend through the insulation, and if the top clamp attachment does not contact the insulation during pipe movement.

3.3.9.1.3 Type 18

Secure Type 18 inserts to concrete forms before concrete is placed. Continuous inserts which allow more adjustment may be used if they otherwise meet the requirements for Type 18 inserts.

3.3.9.1.4 Type 19 and 23 C-Clamps

Torque Type 19 and 23 C-clamps in accordance with **MSS SP-58** and have both locknuts and retaining devices furnished by the manufacturer. Field fabricated C-clamp bodies or retaining devices are not acceptable.

3.3.9.1.5 Type 20 Attachments

Furnish Type 20 attachments used on angles and channels with an added malleable-iron heel plate or adapter.

3.3.9.1.6 Type 24

Type 24 may be used only on trapeze hanger systems or on fabricated frames.

3.3.9.1.7 Horizontal Pipe Supports

Space horizontal pipe supports as specified in **MSS SP-58** and do not install a support over **1 foot** from the pipe fitting joint at each change in direction of the piping. Do not space pipe supports over **5 feet** apart at valves.

3.3.9.1.8 Vertical Pipe Support

Support vertical pipe at each floor, except at slab-on-grade, and at intervals of no more than **15 feet**, no more than **8 feet** from end of risers, and at vent terminations.

3.3.9.1.9 Type 35 Guides

Provide Type 35 guides using steel, reinforced polytetrafluoroethylene (PTFE) or graphite slides where required to allow longitudinal pipe movement. Provide lateral restraints as required. Provide slide materials suitable for the system operating temperatures, atmospheric conditions, and bearing loads encountered.

- a. Where steel slides do not require provisions for restraint of lateral movement, an alternate guide method may be used. On piping **4 inches** and larger, a Type 39 saddle may be welded to the pipe and freely rested on a steel plate. On piping under **4 inches**, a Type 40 protection shield may be attached to the pipe or insulation and freely rested on a steel slide plate.
- b. Where there are high system temperatures and welding to piping is not desirable, include a pipe cradle welded to the guide structure and strapped securely to the pipe. Separate the pipe from the slide material by at least **4 inches** or by an amount adequate for the insulation, whichever is greater.

3.3.9.1.10 Horizontal Insulated Pipe

Except for Type 3, pipe hangers on horizontal insulated pipe must be the size of the outside diameter of the insulation.

3.3.9.1.11 Piping in Trenches

Support piping in trenches as indicated.

3.3.9.1.12 Structural Steel Attachments

Provide structural steel attachments and brackets required to support piping, headers, and equipment, but not shown, under this section.

Do not exceed **50 pounds** for pipe hanger loads suspended from steel joist between panel points. Suspend loads exceeding **50 pounds** from panel points.

3.3.9.2 Multiple Pipe Runs

In the support of multiple pipe runs on a common base member, use a clip or clamp where each pipe crosses the base support member. Spacing of the base support member must not exceed the hanger and support spacing required for any individual pipe in the multiple pipe run. Attach the clips or clamps rigidly to the common base member. Provide a clearance of **1/8 inch** between the pipe insulation and the clip or clamp for piping which may be subjected to thermal expansion.

3.3.10 Anchors

Provide anchors where necessary to localize expansion or to prevent undue strain on piping. Provide anchors consisting of heavy steel collars with lugs and bolts for clamping and attaching anchor braces, unless otherwise indicated. Install anchor braces in the most effective manner to secure the desired results, using turnbuckles where required. Do not attach supports, anchors, or stays where they will injure the structure or adjacent construction during installation or by the weight of expansion of the pipeline.

3.3.11 Valves

Install valves where indicated, specified, and required for functioning and servicing of the systems. Ensure valves are safely accessible. Install swing check valves upright in horizontal lines and in vertical lines only when flow is in the upward direction. Install gate and globe valves with stems horizontal or above. Disassemble valves to be brazed prior to brazing and remove all packing. After brazing, allow the valves to cool before reassembling.

3.3.12 Pipe Sleeves

Provide pipe passing through concrete or masonry walls or concrete floors or roofs with pipe sleeves fitted into place at the time of construction. Install a waterproofing clamping flange as indicated where membranes are involved. Do not install sleeves in structural members except where indicated or approved. Provide rectangular and square openings as detailed. Extend each sleeve through its respective wall. Cut sleeves through walls flush with wall surface. Unless otherwise indicated, size sleeves to provide a minimum clearance of **1/4 inch** between bare pipe and sleeves or between jacket over insulation and sleeves. Use galvanized steel pipe or cast-iron pipe sleeves in waterproofing membrane floors, bearing walls, and wet areas. Sleeves in nonbearing walls, or ceilings may be galvanized steel pipe, cast-iron pipe, or galvanized sheet metal

with lock-type longitudinal seam. Except in pipe chases or interior walls, seal the annular space between pipe and sleeve or between jacket over insulation and sleeve in nonfire rated walls as indicated and specified in Section 07 92 00 JOINT SEALANTS. Provide metal jackets over insulation passing through exterior walls, firewalls, fire partitions, floors, or roofs.

- a. Metal jackets must not be thinner than 0.006 inch thick aluminum, if corrugated, and 0.016 inch thick aluminum, if smooth.
- b. Secure metal jackets with aluminum or stainless steel bands not less than 3/8 inch wide and not more than 8 inches apart. When penetrating roofs and before fitting the metal jacket into place, run a 1/2 inch wide strip of sealant vertically along the inside of the longitudinal joint of the metal jacket from a point below the backup material to a minimum height of 36 inches above the roof. If the pipe turns from vertical to horizontal, run the sealant strip to a point just beyond the first elbow. When penetrating waterproofing membrane for floors, extend the metal jacket from a point below the back-up material to a minimum distance of 2 inches above the flashing. For other areas, extend the metal jacket from a point below the backup material to a point 12 inches above material to a minimum distance of 2 inches above the flashing. For other areas, extend the metal jacket from a point below the backup material to a point 12 inches above the floor; when passing through walls above grade, extend the jacket at least 4 inches beyond each side of the wall.

3.3.12.1 Pipes Passing Through Waterproofing Membranes

In addition to the pipe sleeves referred to above, provide pipes passing through waterproofing membranes with a 4 pound lead flashing or a 16 ounce copper flashing, each within an integral skirt or flange. Suitably form flashing, and extend the skirt or flange no less than 8 inches from the pipe and set over the membrane in a troweled coating of bituminous cement. Extend the flashing above the roof or floor a minimum of 10 inches. Seal the annular space between the flashing and the bare pipe or between the flashing and the metal-jacket-covered insulation as indicated. Pipes up to and including 10 inches in diameter which pass through waterproofing membrane may be installed through a cast-iron sleeve with caulking recess, anchor lugs, flashing clamp device, and pressure ring with brass bolts. Clamp waterproofing membrane into place and place sealant in the caulking recess.

3.3.12.2 Optional Modular Mechanical Sealing Assembly

At the option of the Contractor, a modular mechanical type sealing assembly may be installed in the annular space between the sleeve and conduit or pipe in lieu of a waterproofing clamping flange and caulking and sealing specified above. Provide seals with interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe/conduit and sleeve with corrosion-protected carbon steel bolts, nuts, and pressure plates. Assemble the links loosely with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and each nut. After the seal assembly is properly positioned in the sleeve, tighten the bolt to cause the rubber sealing elements to expand and provide a watertight seal between the pipe/conduit and the sleeve. Size each seal assembly as recommended by the manufacturer to fit the pipe/conduit and sleeve involved.

3.3.12.3 Optional Counterflashing

As alternates to caulking and sealing the annular space between the pipe and flashing or metal-jacket-covered insulation and flashing, counterflashing may consist of standard roof coupling for threaded pipe up to 6 inches in diameter, lead flashing sleeve for dry vents with the sleeve turned down into the pipe to form a waterproof joint, or a tack-welded or banded-metal rain shield around the pipe, sealed as indicated.

3.3.12.4 Fire Seal

Where pipes pass through firewalls, fire partitions, or floors, provide a fire seal as specified in Section 07 84 00 FIRESTOPPING.

3.3.13 Balancing Valves

Install balancing valves as indicated.

3.3.14 Thermometer Wells

Provide a thermometer well in each return line for each circuit in multicircuit systems.

3.3.15 Air Vents

Install air vents in piping at all system high points. Keep the vent open until water rises in the tank or pipe to a predetermined level at which time it must close tight. Run an overflow pipe from the vent to a point designated by the Contracting Officer's representative. Provide inlet to the air vent with a gate valve or ball valve.

3.3.16 Escutcheons

Provide escutcheons at all finished surfaces where exposed piping, bare or insulated, passes through floors, walls, or ceilings except in boiler, utility, or equipment rooms. Fasten chromium-plated iron or chromium-plated brass, either one-piece or split pattern, escutcheons securely to pipe or pipe covering and hold in place by internal spring tension or setscrews.

3.3.17 Drains

Install a drain connection with a 1 inch gate valve or 3/4 inch hose bib at the lowest point in the return main near the boiler. In addition, install threaded drain connections with threaded cap or plug on the heat exchanger coil on each unit heater or unit ventilator and wherever required for thorough draining of the system.

3.3.18 Strainer Blow-Down Piping

Fit strainer blow-down connections with a black steel blow-down pipeline routed to an accessible location and provided with a blow-down valve.

3.3.19 Direct Venting for Combustion Intake Air and Exhaust Air

Install intake air and exhaust vents in accordance with NFPA 54 and boiler manufacturer's recommendations. Slope exhaust vent 1/4 inch/ft toward the boiler's flue gas condensate collection point.

3.4 GAS FUEL SYSTEM

Provide gas piping, fittings, valves, regulators, tests, cleaning, and adjustments in accordance with the Section 23 11 20 FACILITY GAS PIPING. Submit proposed test schedules for the heating system and fuel system tests, at least 2 weeks prior to the start of related testing. Comply with NFPA 54 unless otherwise specified. Provide burners, pilots, and all accessories that are listed in UL FLAMMABLE & COMBUSTIBLE. Provide fuel system with a gas tight, manually operated, UL listed stop valve at the gas-supply connections, a gas strainer, a pressure regulator, pressure gauges, a burner-control valve, a safety shutoff valve suitable for size of burner and sequence of operation, and other components required for safe, efficient, and reliable operation as specified. Provide approved permanent and ready facilities to permit periodic valve leakage tests on the safety shutoff valve or valves.

3.5 RADIANT FLOOR HEATING SYSTEM

3.5.1 Penetrations to Fire Rated Assemblies

Where pipe pass through firewalls, fire partitions, or floors, provide a fire seal as specified in Section 07 84 00 FIRESTOPPING.

3.6 COLOR CODE MARKING AND FIELD PAINTING

Color code marking of piping must be as specified in Section 09 90 00 PAINTS AND COATINGS. Clean, prepare, and paint ferrous metal not specified to be coated at the factory as specified in Section 09 90 00 PAINTS AND COATINGS. Paint exposed pipe covering as specified in Section 09 90 00 PAINTS AND COATINGS. Do not paint aluminum sheath over insulation.

3.7 MANUFACTURER'S SERVICES

Provide the services of a manufacturer's representative who is experienced in the installation, adjustment, and operation of the equipment specified to supervise the installing, adjusting, and testing of the equipment.

3.8 TEST OF BACKFLOW PREVENTION ASSEMBLIES

Test backflow prevention assemblies in accordance with Section 22 00 00 PLUMBING, GENERAL PURPOSE.

3.9 HEATING SYSTEM TESTS

Submit the Qualifications of the firms in charge of installation and testing as specified. Submit a statement from the firms proposed to prepare submittals and perform installation and testing, demonstrating successful completion of similar services of at least five projects of similar size or scope, at least 2 weeks prior to the submittal of any other item required by this section. Before any covering is installed on pipe or heating equipment, hydrostatically test and prove tight the entire heating system's piping, fittings, and terminal heating units at a pressure of 1.5 times the design working pressure, but no less than 100 psi. Submit proposed test procedures for the heating system tests and fuel system tests, at least 2 weeks prior to the start of related testing.

- a. Before pressurizing system for test, blank off items or equipment (e.g., vessels, pumps, instruments, controls, relief valves) rated for pressures below the test pressure or replace with spool pieces.
- b. Before balancing and final operating test, remove test blanks and spool pieces; and reconnect protected instruments and equipment. With equipment items protected, pressurize the system to test pressure. Hold pressure for a period of time sufficient to inspect all welds, joints, and connections for leaks, but no less than 2 hours. No loss of pressure will be allowed. Repair leaks and retest repaired joint.
- c. Repair joints are not allowed under the floor for floor radiant heating systems. If a leak occurs in tubing located under the floor in radiant heating systems, replace the entire zone that is leaking. If any repair is made above the floor for floor radiant heating systems, provide access for the installed joint. Caulking of joints is not permitted.
- d. Drain system and after instruments and equipment are reconnected, refill the system with service medium and maximum operating pressure applied. Hold the pressure while inspecting these joints and connections for leaks. Repair the leaks and retest the repaired joints.

Upon completion of hydrostatic tests and before acceptance of the installation, submit test reports for the heating system tests. Upon completion of testing complete with results, balance the heating system in accordance with Section 23 05 93 TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS and operating tests required to demonstrate satisfactory functional and operational efficiency. Cover a period of at least 24 hours for each system, and include, as a minimum, the following specific information in a report, together with conclusions as to the adequacy of the system:

- a. Certification of balancing.
- b. Time, date, and duration of test.
- c. Outside and inside dry bulb temperatures.
- d. Temperature of hot water supply leaving boiler .
- e. Temperature of heating return water from system at boiler inlet.
- f. Quantity of water feed to boiler.
- g. Boiler make, type, serial number, design pressure, and rated capacity.
- h. Fuel burner make, model, and rated capacity; ammeter and voltmeter readings for burner motor.
- j. Flue-gas temperature at boiler outlet.
- k. Percent carbon dioxide in flue-gas.
- l. Grade or type and calorific value of fuel.
- m. Draft at boiler flue-gas exit.

- n. Draft or pressure in furnace.
- o. Quantity of water circulated.
- p. Quantity of fuel consumed.
- q. Stack emission pollutants concentration.

Read indicating instruments at half-hour intervals unless otherwise directed. Furnish all instruments, equipment, and personnel required for the tests and balancing. Obtain necessary natural gas, water and electricity as specified in the Section 01 50 00 TEMPORARY CONSTRUCTION FACILITIES AND CONTROLS. Demonstrate that fuel burners and combustion and safety controls meet the requirements of ASME CSD-1.

3.9.1 Water Treatment Testing

Analyze the boiler water prior to the acceptance of the facility by the water treatment company. Submit a water quality test report identifying the chemical composition of the boiler water. Include a comparison of the condition of the boiler water with the manufacturer's recommended conditions. Document any required corrective action within the report. Identify the condition of the boiler at the completion of 1 year of service. Include a comparison of the condition of the boiler with the manufacturer's recommended operating conditions. Include the following information recorded in accordance with ASTM D596 in the analysis.

Date of Sample	_____
Temperature	_____ degrees F
Silica (SiO ₂)	_____ ppm (mg/1)
Insoluble	_____ ppm (mg/1)
Iron and Aluminum Oxides	_____ ppm (mg/1)
Calcium (Ca)	_____ ppm (mg/1)
Magnesium (Mg)	_____ ppm (mg/1)
Sodium and Potassium (Na and K)	_____ ppm (mg/1)
Carbonate (HCO ₃)	_____ ppm (mg/1)
Sulfate (SO ₄)	_____ ppm (mg/1)
Chloride (Cl)	_____ ppm (mg/1)
Nitrate (NO ₃)	_____ ppm (mg/1)
Turbidity	_____ ntu
pH	_____

Residual Chlorine	___ ppm (mg/1)
Total Alkalinity	___ epm (meq/1)
Noncarbonate Hardness	___ epm (meq/1)
Total Hardness	___ epm (meq/1)
Dissolved Solids	___ ppm (mg/1)
Fluorine	___ ppm (mg/1)
Conductivity	___ micro-mho/cm

If the boiler water is not in conformance with the boiler manufacturer's recommendations, the water treatment company must take corrective action.

3.9.2 Boiler/Piping Test

At the conclusion of the 1 year period, inspect the boiler and condensate piping for problems due to corrosion and scale. If the boiler is found not to conform to the manufacturer's recommendations, and the water treatment company recommendations have been followed, the water treatment company must provide all chemicals and labor for cleaning or repairing the equipment as required by the manufacturer's recommendations. If corrosion is found within the condensate piping, make proper repairs.

3.10 CLEANING

3.10.1 Boilers and Piping

After the hydrostatic tests have been made and before the system is balanced and operating tests are performed, thoroughly clean the boilers and piping by filling the system with a solution consisting of either **1 pound** of caustic soda or **1 pound** of trisodium phosphate per **50 gallons** of water. Observe proper safety precautions in the handling and use of these chemicals. Heat the water to approximately **150 degrees F** and circulate the solution in the system for a period of 48 hours. Then drain the system and thoroughly flush out with fresh water. Thoroughly clean strainers and valves. Prior to operating tests, remove air from all water systems by operating the air vents.

3.10.2 Heating Units

Thoroughly clean inside space heating equipment, ducts, plenums, and casing of debris and blow free of small particles of rubbish and dust and then vacuum clean before installing outlet faces. Wipe equipment clean, with all traces of oil, dust, dirt, or paint spots removed. Provide temporary filters for fans that are operated during construction, and provide new filters after construction dirt has been removed from the building, and the ducts, plenum, casings, and other items specified have been vacuum cleaned. Perform and document that proper "**Indoor Air Quality During Construction**" procedures have been followed; provide documentation showing that after construction ends, and prior to occupancy, new filters were provided and installed. Maintain system in this clean condition

until final acceptance. Lubricate bearings properly with oil or grease as recommended by the manufacturer. Tighten belts to proper tension. Adjust control valves and other miscellaneous equipment requiring adjustment to setting indicated or directed. Adjust fans to the speed indicated by the manufacturer to meet specified conditions.

3.11 FIELD TRAINING

Conduct a training course for the operating staff as designated by the Contracting Officer. The training period consists of a total of 8 hours of normal working time and start after the system is functionally completed but prior to final acceptance tests.

- a. Cover all of the items contained in the approved operation and maintenance manuals, as well as demonstrations of routine maintenance operations and boiler safety devices, in the [field instructions](#).
- b. Submit system layout diagrams that show the layout of equipment, piping, and ductwork and typed condensed operation manuals explaining preventative maintenance procedures, methods of checking the system for normal, safe operation, and procedures for safely starting and stopping the system, framed under glass or laminated plastic, at least 2 weeks prior to the start of related testing. After approval, post these items where directed.
- c. Submit six complete [operation and maintenance instructions](#) listing step-by-step procedures required for system startup, operation, shutdown, and routine maintenance, at least 2 weeks prior to field training. Include the manufacturer's name, model number, parts list, simplified wiring and control diagrams, troubleshooting guide, and recommended service organization (including address and telephone number) for each item of equipment. Each service organization must be capable of providing 4 hour onsite response to a service call on an emergency basis.
- d. Notify the Contracting Officer at least 14 days prior to date of proposed conduction of the training course.

3.12 FUEL SYSTEM TESTS

Submit test reports for the fuel system tests, upon completion of testing complete with results.

3.12.1 Gas System Test

Test gas fuel system accordance with the test procedures outlined in [NFPA 54](#).

-- End of Section --

SECTION 23 64 26

CHILLED, CHILLED-HOT, AND CONDENSER WATER PIPING SYSTEMS

08/09, CHG 6: 11/22

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.20.1	(2013; R 2018) Pipe Threads, General Purpose (Inch)
ASME B16.1	(2020) Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250
ASME B16.3	(2021) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.9	(2018) Factory-Made Wrought Buttwelding Fittings
ASME B16.11	(2022) Forged Fittings, Socket-Welding and Threaded
ASME B16.21	(2021) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.39	(2020) Standard for Malleable Iron Threaded Pipe Unions; Classes 150, 250, and 300
ASME B31.9	(2020) Building Services Piping
ASME BPVC SEC IX	(2017; Errata 2018) BPVC Section IX-Welding, Brazing and Fusing Qualifications

AMERICAN WELDING SOCIETY (AWS)

AWS BRH	(2007; 5th Ed) Brazing Handbook
AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel
AWS Z49.1	(2021) Safety in Welding and Cutting and Allied Processes

ASTM INTERNATIONAL (ASTM)

ASTM A53/A53M	(2022) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

ASTM A653/A653M	(2022) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A733	(2016; R 2022) Standard Specification for Welded and Seamless Carbon Steel and Austenitic Stainless Steel Pipe Nipples
ASTM B117	(2019) Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM D520	(2000; R 2011) Zinc Dust Pigment
ASTM D3308	(2012; R 2017) Standard Specification for PTFE Resin Skived Tape
ASTM E84	(2020) Standard Test Method for Surface Burning Characteristics of Building Materials

HYDRAULIC INSTITUTE (HI)

HI 1.1-1.2	(2014) Rotodynamic (Centrifugal) Pump for Nomenclature and Definitions

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-25	(2018) Standard Marking System for Valves, Fittings, Flanges and Unions
MSS SP-58	(2018) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation
MSS SP-69	(2003; Notice 2012) Pipe Hangers and Supports - Selection and Application (ANSI Approved American National Standard)

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2020) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA MG 1	(2021) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 90A	(2021) Standard for the Installation of Air Conditioning and Ventilating Systems

1.2 SYSTEM DESCRIPTION

Provide the water systems having the minimum service (design) temperature-pressure rating indicated. Provision of the piping systems, including materials, installation, workmanship, fabrication, assembly, erection, examination, inspection, and testing shall be in accordance with

the required and advisory provisions of ASME B31.9 except as modified or supplemented by this specification section or design drawings. This specification section covers the water systems piping which is located within, on, and adjacent to building(s) within the building(s) 5 foot line.

1.3 SUBMITTALS

Government approval is required for submittals. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Pumps;

Expansion Tanks

Air Separator Tanks

Water Treatment Systems;

Proposed water treatment plan including a layout, control scheme, a list of existing make-up water conditions including the items listed in paragraph WATER ANALYSIS", a list of chemicals, the proportion of chemicals to be added, the final treated water conditions, and a description of environmental concerns for handling the chemicals.

SD-06 Test Reports

Piping Welds NDE Report

Pressure Tests Reports;

Report shall be provided in bound 8-1/2 by 11 inch booklets. In the reports, document all phases of the tests performed. Include initial test summaries, all repairs/adjustments made, and the final test results.

SD-07 Certificates

Employer's Record Documents (For Welding)

Welding Procedures and Qualifications

Certificates shall be submitted for the following items showing conformance with the referenced standards contained in this section.

SD-08 Manufacturer's Instructions

Lesson plan for the Instruction Course;

SD-10 Operation and Maintenance Data

Requirements for data packages are specified Section 01 78 23 OPERATION AND MAINTENANCE DATA, except as supplemented and modified by this specification section.

Submit spare parts data for each different item of equipment

specified, with operation and maintenance data packages. Include a complete list of parts and supplies, with current unit prices and source of supply, a recommended spare parts list for 1 year of operation, and a list of the parts recommended by the manufacturer to be replaced on a routine basis.

Submit a list of qualified permanent service organizations with operation and maintenance data packages. Include service organization addresses and service area or expertise. The service organizations shall be reasonably convenient to the equipment installation and be able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

Water Treatment Systems;

An operation manual in bound 8-1/2 by 11 inch booklets listing step-by-step procedures required for system startup, operation, abnormal shutdown, emergency shutdown, and normal shutdown. Include testing procedures used in determining water quality.

A maintenance manual in bound 8-1/2 by 11 inch booklets listing routine maintenance procedures, possible breakdowns and repairs, and a trouble shooting guide.

Pumps, Data Package 3;

Expansion Tanks, Data Package 2;

Air Separator Tanks, Data Package 2;

1.4 MODIFICATIONS TO REFERENCES

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction", or words of similar meaning, to mean the Contracting Officer.

1.4.1 Definitions

For the International Code Council (ICC) Codes referenced in the contract documents, advisory provisions shall be considered mandatory, the word "should" shall be interpreted as "shall." Reference to the "code official" shall be interpreted to mean the "Contracting Officer." For Navy owned property, references to the "owner" shall be interpreted to mean the "Contracting Officer." For leased facilities, references to the "owner" shall be interpreted to mean the "lessor." References to the "permit holder" shall be interpreted to mean the "Contractor."

1.4.2 Administrative Interpretations

For ICC Codes referenced in the contract documents, the provisions of Chapter 1, "Administrator," do not apply. These administrative requirements are covered by the applicable Federal Acquisition Regulations (FAR) included in this contract and by the authority granted to the Officer in Charge of Construction to administer the construction of this project. References in the ICC Codes to sections of Chapter 1, shall be applied appropriately by the Contracting Officer as authorized by his

administrative cognizance and the FAR.

1.5 SAFETY REQUIREMENTS

Exposed moving parts, parts that produce high operating temperature, parts which may be electrically energized, and parts that may be a hazard to operating personnel shall be insulated, fully enclosed, guarded, or fitted with other types of safety devices. Safety devices shall be installed so that proper operation of equipment is not impaired.

1.6 DELIVERY, STORAGE, AND HANDLING

Protect stored items from the weather, humidity and temperature variations, dirt and dust, or other contaminants. Proper protection and care of all material both before and during installation shall be the Contractor's responsibility. Any materials found to be damaged shall be replaced at the Contractor's expense. During installation, cap piping and similar openings to keep out dirt and other foreign matter. Any porous materials found to be contaminated with mold or mildew will be replaced at the Contractor's expense. Non-porous materials found to be contaminated with mold or mildew will be disinfected and cleaned prior to installation.

1.7 PROJECT/SITE CONDITIONS

1.7.1 Verification of Dimensions

The Contractor shall become familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing any work.

1.7.2 Drawings

Because of the small scale of the drawings, it is not possible to indicate all offsets, fittings, and accessories that may be required. The Contractor shall carefully investigate the plumbing, fire protection, electrical, structural and finish conditions that would affect the work to be performed and shall arrange such work accordingly, furnishing required offsets, fittings, and accessories to meet such conditions.

1.7.3 Accessibility

Install all work so that parts requiring periodic inspection, operation, maintenance, and repair are readily accessible. Install concealed valves, expansion joints, controls, dampers, and equipment requiring access, in locations freely accessible through access doors.

PART 2 PRODUCTS

2.1 STANDARD COMMERCIAL PRODUCTS

Materials and equipment shall be standard products of a manufacturer regularly engaged in the manufacturing of such products, which are of a similar material, design and workmanship. The standard products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening.

The two year use shall include applications of equipment and materials under similar circumstances and of similar size. The 2 years experience shall be satisfactorily completed by a product which has been sold or is

offered for sale on the commercial market through advertisements, manufacturer's catalogs, or brochures.

Products having less than a 2 year field service record shall be acceptable if a certified record of satisfactory field operation, for not less than 6000 hours exclusive of the manufacturer's factory tests, can be shown. System components shall be environmentally suitable for the indicated locations.

The equipment items shall be supported by service organizations. These service organizations shall be reasonably convenient to the equipment installation and able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

2.2 STEEL PIPING

Water piping shall be steel pipe or copper tubing. Provide steel piping with a ANSI/ASME Class 125 service rating, which for 150 degrees F, the pressure rating is 175 psig.

2.2.1 Pipe

Steel pipe, conform to ASTM A53/A53M, Schedule 40, Type E or S, Grades A or B. Do not use Type F pipe.

2.2.2 Fittings and End Connections (Joints)

Piping and fittings 1 inch and smaller shall have threaded connections. Piping and fittings larger than 1 inch and smaller than 3 inches shall have either threaded, or welded connections. Piping and fittings 3 inches and larger shall have welded, or flanged connections. The manufacturer of each fitting shall be permanently identified on the body of the fitting in accordance with MSS SP-25.

2.2.2.1 Threaded Connections

Use threaded valves and pipe connections conforming to ASME B1.20.1. Used threaded fitting conforming to ASME B16.3. Use threaded unions conforming to ASME B16.39. Use threaded pipe nipples conforming to ASTM A733.

2.2.2.2 Flanged Connections

Flanges shall conform to ASME B16.1, Class 125. Gaskets shall be nonasbestos compressed material in accordance with ASME B16.21, 1/16 inch thickness, full face or self-centering flat ring type. These gaskets shall contain aramid fibers bonded with styrene butadiene rubber (SBR) or nitrile butadiene rubber (NBR). Bolts, nuts, and bolt patterns shall conform to ASME B16.1.

2.2.2.3 Welded Connections

Welded valves and pipe connections (both butt-welds and socket-welds types) shall conform to ASME B31.9. Butt-welded fittings shall conform to ASME B16.9. Socket-welded fittings shall conform to ASME B16.11. Welded fittings shall be identified with the appropriate grade and marking symbol.

2.2.2.4 Dielectric Waterways and Flanges

Provide dielectric waterways with a water impervious insulation barrier

capable of limiting galvanic current to 1 percent of short circuit current in a corresponding bimetallic joint. When dry, insulation barrier shall be able to withstand a 600-volt breakdown test. Provide dielectric waterways constructed of galvanized steel and have threaded end connections to match connecting piping. Dielectric waterways shall be suitable for the required operating pressures and temperatures. Provide dielectric flanges with the same pressure ratings as standard flanges and provide complete electrical isolation between connecting pipe and/or equipment as described herein for dielectric waterways.

2.3 PUMPS

Pumps shall be the electrically driven, non-overloading, centrifugal type which conform to **HI 1.1-1.2**. Pumps shall be selected at or within 5 percent of peak efficiency. Pump curve shall rise continuously from maximum capacity to shutoff. Pump motor shall conform to **NEMA MG 1**, be open , and have sufficient **horsepower** for the service required. Pump motor shall have the required capacity to prevent overloading with pump operating at any point on its characteristic curve. Pump speed shall not exceed 3,600 rpm, except where the pump head is less than **60 feet of water**, the pump speed shall not exceed 1,750 rpm. Pump motor shall be equipped with an across-the-line magnetic controller in a **NEMA 250**, Type 1 enclosure with "START-STOP" switch in the cover.

2.3.1 Construction

Each pump casing shall be designed to withstand the discharge head specified plus the static head on system plus 50 percent of the total, but not less than **125 psig**. Pump casing and bearing housing shall be close grained cast iron. High points in the casing shall be provided with manual air vents; low points shall be provided with drain plugs. Provide threaded suction and discharge pressure gage tapping with square-head plugs.

Impeller shall be statically and dynamically balanced. Impeller, impeller wearing rings, glands, casing wear rings, and shaft sleeve shall be bronze. Shaft shall be carbon or alloy steel, turned and ground. Bearings shall be ball-bearings, roller-bearings, or oil-lubricated bronze-sleeve type bearings, and be efficiently sealed or isolated to prevent loss of oil or entrance of dirt or water.

Close-coupled pump shall be provided with integrally cast or fabricated steel feet with bolt holes for securing feet to supporting surface. Close-coupled pumps shall be provided with drip pockets and tapped openings. Pump shall be accessible for servicing without disturbing piping connections. Shaft seals shall be mechanical-seals or stuffing-box type.

2.3.2 Mechanical Shaft Seals

Seals shall be single, inside mounted, end-face-elastomer bellows type with stainless steel spring, brass or stainless steel seal head, carbon rotating face, and tungsten carbide or ceramic sealing face. Glands shall be bronze and of the water-flush design to provide lubrication flush across the face of the seal. Bypass line from pump discharge to flush connection in gland shall be provided, with filter or cyclone particle separator in line.

2.3.3 Stuffing-Box Type Seals

Stuffing box shall include minimum 4 rows of square, impregnated TFE (Teflon) or graphite cord packing and a bronze split-lantern ring. Packing gland shall be bronze interlocking split type.

2.4 EXPANSION TANKS

Tank shall be welded steel, constructed for, and tested to pressure-temperature rating of 125 psi at 150 degrees F. Provide tanks precharged to the minimum operating pressure. Tank shall have a replaceable polypropylene or butyl lined diaphragm which keeps the air charge separated from the water; shall be the captive air type.

Tanks shall accommodate expanded water of the system generated within the normal operating temperature range, limiting this pressure increase at all components in the system to the maximum allowable pressure at those components. Each tank air chamber shall be fitted with a drain, fill, an air charging valve, and system connections. Tank shall be supported by steel legs or bases for vertical installation or steel saddles for horizontal installations. The only air in the system shall be the permanent sealed-in air cushion contained within the expansion tank.

2.5 AIR SEPARATOR TANKS

Design to separate air from water and to direct released air to automatic air vent. Unit shall be of one piece cast-iron construction with internal baffles and two air chambers at top of unit; one air chamber shall have outlet to expansion tank and other air chamber shall be provided with automatic air release device. Tank shall be steel, constructed for, and tested to a ANSI Class 125 pressure-temperature rating.

2.6 WATER TREATMENT SYSTEMS

When water treatment is specified, the use of chemical-treatment products containing equivalent chromium (CPR) is prohibited.

2.6.1 Chilled and Condenser Water

Water to be used in the chilled and condenser water systems shall be treated to maintain the conditions recommended by this specification as well as the recommendations from the manufacturers of the condenser and evaporator coils. Chemicals shall meet all required federal, state, and local environmental regulations for the treatment of evaporator coils and direct discharge to the sanitary sewer.

2.6.2 Water Treatment Services

The services of a company regularly engaged in the treatment of chilled water systems shall be used to determine the correct chemicals required, the concentrations required, and the water treatment equipment sizes and flow rates required. The company shall maintain the chemical treatment and provide all chemicals required for the chilled water systems for a period of 1 year from the date of occupancy. The chemical treatment and services provided over the 1 year period shall meet the requirements of this specification as well as the recommendations from the manufacturers of the condenser and evaporator coils. Acid treatment and proprietary

chemicals shall not be used.

2.6.3 Chilled Water System

A shot feeder shall be provided on the chilled water piping as indicated. Size and capacity of feeder shall be based on local requirements and water analysis. The feeder shall be furnished with an air vent, gauge glass, funnel, valves, fittings, and piping.

2.7 PAINTING OF NEW EQUIPMENT

New equipment painting shall be factory applied or shop applied, and shall be as specified herein, and provided under each individual section.

2.7.1 Factory Painting Systems

Manufacturer's standard factory painting systems may be provided. The factory painting system applied will withstand 125 hours in a salt-spray fog test, except that equipment located outdoors shall withstand 500 hours in a salt-spray fog test.

Salt-spray fog test shall be in accordance with [ASTM B117](#), and for that test, the acceptance criteria shall be as follows: immediately after completion of the test, the paint shall show no signs of blistering, wrinkling, or cracking, and no loss of [0.125 inch](#) on either side of the scratch mark. The film thickness of the factory painting system applied on the equipment shall not be less than the film thickness used on the test specimen.

If manufacturer's standard factory painting system is being proposed for use on surfaces subject to temperatures above [120 degrees F](#), the factory painting system shall be designed for the temperature service.

2.7.2 Shop Painting Systems for Metal Surfaces

Clean, retreat, prime and paint metal surfaces; except aluminum surfaces need not be painted. Apply coatings to clean dry surfaces. Clean the surfaces to remove dust, dirt, rust, oil and grease by wire brushing and solvent degreasing prior to application of paint, except metal surfaces subject to temperatures in excess of [120 degrees F](#) shall be cleaned to bare metal.

Where hot-dip galvanized steel has been cut, resulting surfaces with no galvanizing shall be coated with a zinc-rich coating conforming to [ASTM D520](#), Type I.

Where more than one coat of paint is specified, apply the second coat after the preceding coat is thoroughly dry. Lightly sand damaged painting and retouch before applying the succeeding coat. Color of finish coat shall be aluminum or light gray.

- a. Temperatures Less Than [120 Degrees F](#): Immediately after cleaning, the metal surfaces subject to temperatures less than [120 degrees F](#) shall receive one coat of pretreatment primer applied to a minimum dry film thickness of [0.3 mil](#); one coat of primer applied to a minimum dry film thickness of [one mil](#); and two coats of enamel applied to a minimum dry film thickness of [one mil](#) per coat.
- b. Temperatures Between [120 and 400 degrees F](#): Metal surfaces subject to

temperatures between 120 and 400 degrees F shall receive two coats of 400 degrees F heat-resisting enamel applied to a total minimum thickness of 2 mils.

- c. Temperatures Greater Than 400 degrees F: Metal surfaces subject to temperatures greater than 400 degrees F shall receive two coats of 600 degrees F heat-resisting paint applied to a total minimum dry film thickness of 2 mils.

2.8 FACTORY APPLIED INSULATION

Factory insulated items installed outdoors are not required to be fire-rated. As a minimum, factory insulated items installed indoors shall have a flame spread index no higher than 25 and a smoke developed index no higher than 150. Factory insulated items (no jacket) installed indoors and which are located in air plenums, in ceiling spaces, and in attic spaces shall have a flame spread index no higher than 25 and a smoke developed index no higher than 50. Flame spread and smoke developed indexes shall be determined by ASTM E84.

Insulation shall be tested in the same density and installed thickness as the material to be used in the actual construction. Material supplied by a manufacturer with a jacket shall be tested as a composite material. Jackets, facings, and adhesives shall have a flame spread index no higher than 25 and a smoke developed index no higher than 50 when tested in accordance with ASTM E84.

2.9 NAMEPLATES

Major equipment including pumps, pump motors, expansion tanks, and air separator tanks shall have the manufacturer's name, type or style, model or serial number on a plate secured to the item of equipment. The nameplate of the distributing agent will not be acceptable. Plates shall be durable and legible throughout equipment life and made of anodized aluminum. Plates shall be fixed in prominent locations with nonferrous screws or bolts.

2.10 RELATED COMPONENTS/SERVICES

2.10.2 Field Applied Insulation

Requirements for field applied insulation is specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

2.10.3 Field Applied Insulation

Requirements for field installed insulation is specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS, except as supplemented and modified by this specification section.

2.10.4 Field Painting

Requirements for painting of surfaces not otherwise specified, and finish painting of items only primed at the factory, are specified in Section

09 90 00 PAINTS AND COATINGS.

PART 3 EXECUTION

3.1 INSTALLATION

Cut pipe accurately to measurements established at the jobsite, and work into place without springing or forcing, completely clearing all windows, doors, and other openings. Cutting or other weakening of the building structure to facilitate piping installation is not permitted without written approval. Cut pipe or tubing square, remove burrs by reaming, and fashion to permit free expansion and contraction without causing damage to the building structure, pipe, joints, or hangers.

Notify the Contracting Officer in writing at least 15 calendar days prior to the date the connections are required. Obtain approval before interrupting service. Furnish materials required to make connections into existing systems and perform excavating, backfilling, compacting, and other incidental labor as required. Furnish labor and tools for making actual connections to existing systems.

3.1.1 Welding

Provide welding work specified this section for piping systems in conformance with ASME B31.9, as modified and supplemented by this specification section and the accompanying drawings. The welding work includes: qualification of welding procedures, welders, welding operators, brazers, brazing operators, and nondestructive examination personnel; maintenance of welding records, and examination methods for welds.

3.1.1.1 Employer's Record Documents (For Welding)

Submit for review and approval the following documentation. This documentation and the subject qualifications shall be in compliance with ASME B31.9.

- a. List of qualified welding procedures that is proposed to be used to provide the work specified in this specification section.
- b. List of qualified welders, brazers, welding operators, and brazing operators that are proposed to be used to provide the work specified in this specification section.
- c. List of qualified weld examination personnel that are proposed to be used to provide the work specified in this specification section.

3.1.1.2 Welding Procedures and Qualifications

- a. Specifications and Test Results: Submit copies of the welding procedures specifications and procedure qualification test results for each type of welding required. Approval of any procedure does not relieve the Contractor of the responsibility for producing acceptable welds. Submit this information on the forms printed in ASME BPVC SEC IX or their equivalent.
- b. Certification: Before assigning welders or welding operators to the work, submit a list of qualified welders, together with data and certification that each individual is performance qualified as specified. Do not start welding work prior to submitting welder, and

welding operator qualifications. The certification shall state the type of welding and positions for which each is qualified, the code and procedure under which each is qualified, date qualified, and the firm and individual certifying the qualification tests.

3.1.1.3 Examination of Piping Welds

Conduct non-destructive examinations (NDE) on piping welds and brazing and verify the work meets the acceptance criteria specified in [ASME B31.9](#). NDE on piping welds covered by [ASME B31.9](#) is visual inspection only. Submit a [piping welds NDE report](#) meeting the requirements specified in [ASME B31.9](#).

3.1.1.4 Welding Safety

Welding and cutting safety requirements shall be in accordance with [AWS Z49.1](#).

3.1.2 Directional Changes

Make changes in direction with fittings, except that bending of pipe [4 inches](#) and smaller is permitted, provided a pipe bender is used and wide weep bends are formed. Mitering or notching pipe or other similar construction to form elbows or tees is not permitted. The centerline radius of bends shall not be less than 6 diameters of the pipe. Bent pipe showing kinks, wrinkles, flattening, or other malformations is not acceptable.

3.1.3 Functional Requirements

Pitch horizontal supply mains down in the direction of flow as indicated. The grade shall not be less than [1 inch in 40 feet](#). Reducing fittings shall be used for changes in pipe sizes. Cap or plug open ends of pipelines and equipment during installation to keep dirt or other foreign materials out of the system.

Pipe not otherwise specified shall be uncoated. Connections to appliances shall be made with malleable iron unions for steel pipe [2-1/2 inches](#) or less in diameter, and with flanges for pipe [3 inches](#) and above in diameter. Connections between ferrous and copper piping shall be electrically isolated from each other with dielectric waterways or flanges.

Piping located in air plenums shall conform to [NFPA 90A](#) requirements. Pipe and fittings installed in inaccessible conduits or trenches under concrete floor slabs shall be welded. Equipment and piping arrangements shall fit into space allotted and allow adequate acceptable clearances for installation, replacement, entry, servicing, and maintenance. Electric isolation fittings shall be provided between dissimilar metals.

3.1.4 Fittings and End Connections

3.1.4.1 Threaded Connections

Threaded connections shall be made with tapered threads and made tight with PTFE tape complying with [ASTM D3308](#) or equivalent thread-joint compound applied to the male threads only. Not more than three threads shall show after the joint is made.

3.1.4.2 Brazed Connections

Brazing, **AWS BRH**, except as modified herein. During brazing, the pipe and fittings shall be filled with a pressure regulated inert gas, such as nitrogen, to prevent the formation of scale. Before brazing copper joints, both the outside of the tube and the inside of the fitting shall be cleaned with a wire fitting brush until the entire joint surface is bright and clean. Do not use brazing flux. Surplus brazing material shall be removed at all joints. Steel tubing joints shall be made in accordance with the manufacturer's recommendations. Piping shall be supported prior to brazing and not be sprung or forced.

3.1.4.3 Welded Connections

Branch connections shall be made with welding tees or forged welding branch outlets. Pipe shall be thoroughly cleaned of all scale and foreign matter before the piping is assembled. During welding, the pipe and fittings shall be filled with an inert gas, such as nitrogen, to prevent the formation of scale. Beveling, alignment, heat treatment, and inspection of weld shall conform to **ASME B31.9**. Weld defects shall be removed and rewelded at no additional cost to the Government. Electrodes shall be stored and dried in accordance with **AWS D1.1/D1.1M** or as recommended by the manufacturer. Electrodes that have been wetted or that have lost any of their coating shall not be used.

3.1.4.4 Flared Connections

When flared connections are used, a suitable lubricant shall be used between the back of the flare and the nut in order to avoid tearing the flare while tightening the nut.

3.1.4.5 Flanges and Unions

Except where copper tubing is used, union or flanged joints shall be provided in each line immediately preceding the connection to each piece of equipment or material requiring maintenance such as coils, pumps, control valves, and other similar items. Flanged joints shall be assembled square end tight with matched flanges, gaskets, and bolts. Gaskets shall be suitable for the intended application.

3.1.5 Valves

Isolation gate or ball valves shall be installed on each side of each piece of equipment, at the midpoint of all looped mains, and at any other points indicated or required for draining, isolating, or sectionalizing purpose. Each valve except check valves shall be identified. Valves in horizontal lines shall be installed with stems horizontal or above.

3.1.6 Air Vents

Air vents shall be provided at all high points, on all water coils, and where indicated to ensure adequate venting of the piping system.

3.1.7 Drains

Drains shall be provided at all low points and where indicated to ensure complete drainage of the piping. Drains shall be accessible, and shall consist of nipples and caps or plugged tees unless otherwise indicated.

3.1.8 Flexible Pipe Connectors

Connectors shall be attached to components in strict accordance with the latest printed instructions of the manufacturer to ensure a vapor tight joint. Hangers, when required to suspend the connectors, shall be of the type recommended by the flexible pipe connector manufacturer and shall be provided at the intervals recommended.

3.1.9 Temperature Gauges

Temperature gauges shall be located on coolant supply and return piping at each heat exchanger, on condenser water piping entering and leaving a condenser, at each automatic temperature control device without an integral thermometer, and where indicated or required for proper operation of equipment. Thermal wells for insertion thermometers and thermostats shall extend beyond thermal insulation surface not less than 1 inch.

3.1.10 Pipe Hangers, Inserts, and Supports

Pipe hangers, inserts, and supports shall conform to MSS SP-58 and MSS SP-69, except as supplemented and modified in this specification section. Pipe hanger types 5, 12, and 26 shall not be used. Hangers used to support piping 2 inches and larger shall be fabricated to permit adequate adjustment after erection while still supporting the load. Piping subjected to vertical movement, when operating temperatures exceed ambient temperatures, shall be supported by variable spring hangers and supports or by constant support hangers.

3.1.10.1 Hangers

Type 3 shall not be used on insulated piping. Type 24 may be used only on trapeze hanger systems or on fabricated frames.

3.1.10.2 Inserts

Type 18 inserts shall be secured to concrete forms before concrete is placed. Continuous inserts which allow more adjustments may be used if they otherwise meet the requirements for Type 18 inserts.

3.1.10.3 C-Clamps

Type 19 and 23 C-clamps shall be torqued per MSS SP-69 and have both locknuts and retaining devices, furnished by the manufacturer. Field-fabricated C-clamp bodies or retaining devices are not acceptable.

3.1.10.4 Angle Attachments

Type 20 attachments used on angles and channels shall be furnished with an added malleable-iron heel plate or adapter.

3.1.10.5 Saddles and Shields

Where Type 39 saddle or Type 40 shield are permitted for a particular pipe attachment application, the Type 39 saddle, connected to the pipe, shall be used on all pipe 4 inches and larger when the temperature of the medium is 60 degrees F or higher. Type 40 shields shall be used on all piping less than 4 inches and all piping 4 inches and larger carrying medium less than 60 degrees F. A high density insulation insert of cellular glass shall be used under the Type 40 shield for piping 2 inches and larger.

3.1.10.6 Horizontal Pipe Supports

Horizontal pipe supports shall be spaced as specified in **MSS SP-69** and a support shall be installed not over **1 foot** from the pipe fitting joint at each change in direction of the piping. Pipe supports shall be spaced not over **5 feet** apart at valves.

3.1.10.7 Vertical Pipe Supports

Vertical pipe shall be supported at each floor, except at slab-on-grade, and at intervals of not more than **15 feet**, not more than **8 feet** from end of risers, and at vent terminations.

3.1.10.8 Pipe Guides

Type 35 guides using, steel, reinforced polytetrafluoroethylene (PTFE) or graphite slides shall be provided where required to allow longitudinal pipe movement. Lateral restraints shall be provided as required. Slide materials shall be suitable for the system operating temperatures, atmospheric conditions, and bearing loads encountered.

3.1.10.9 Steel Slides

Where steel slides do not require provisions for restraint of lateral movement, an alternate guide method may be used. On piping **4 inches** and larger, a Type 39 saddle shall be used. On piping under **4 inches**, a Type 40 protection shield may be attached to the pipe or insulation and freely rest on a steel slide plate.

3.1.10.10 Multiple Pipe Runs

In the support of multiple pipe runs on a common base member, a clip or clamp shall be used where each pipe crosses the base support member. Spacing of the base support members shall not exceed the hanger and support spacing required for an individual pipe in the multiple pipe run.

3.1.10.11 Structural Attachments

Attachment to building structure concrete and masonry shall be by cast-in concrete inserts, built-in anchors, or masonry anchor devices. Inserts and anchors shall be applied with a safety factor not less than 5. Supports shall not be attached to metal decking. Supports shall not be attached to the underside of concrete filled floors or concrete roof decks unless approved by the Contracting Officer. Masonry anchors for overhead applications shall be constructed of ferrous materials only. Structural steel brackets required to support piping, headers, and equipment, but not shown, shall be provided under this section. Material used for support shall be as specified under Section **05 12 00** STRUCTURAL STEEL.

3.1.11 Pipe Alignment Guides

Pipe alignment guides shall be provided where indicated for expansion loops, offsets, and bends and as recommended by the manufacturer for expansion joints, not to exceed **5 feet** on each side of each expansion joint, and in lines **4 inches** or smaller not more than **2 feet** on each side of the joint.

3.1.12 Pipe Anchors

Anchors shall be provided where indicated. Unless indicated otherwise, anchors shall comply with the requirements specified. Anchors shall consist of heavy steel collars with lugs and bolts for clamping and attaching anchor braces, unless otherwise indicated. Anchor braces shall be installed in the most effective manner to secure the desired results using turnbuckles where required.

Supports, anchors, or stays shall not be attached where they will injure the structure or adjacent construction during installation or by the weight of expansion of the pipeline. Where pipe and conduit penetrations of vapor barrier sealed surfaces occur, these items shall be anchored immediately adjacent to each penetrated surface, to provide essentially zero movement within penetration seal.

3.1.13 Building Surface Penetrations

Sleeves shall not be installed in structural members except where indicated or approved. Except as indicated otherwise piping sleeves shall comply with requirements specified. Sleeves in nonload bearing surfaces shall be galvanized sheet metal, conforming to [ASTM A653/A653M](#), Coating Class G-90, [20 gauge](#). Sleeves in load bearing surfaces shall be uncoated carbon steel pipe, conforming to [ASTM A53/A53M](#), Standard weight. Sealants shall be applied to moisture and oil-free surfaces and elastomers to not less than [1/2 inch](#) depth. Sleeves shall not be installed in structural members.

3.1.13.1 Refrigerated Space

Refrigerated space building surface penetrations shall be fitted with sleeves fabricated from hand-lay-up or helically wound, fibrous glass reinforced polyester or epoxy resin with a minimum thickness equal to equivalent size Schedule 40 steel pipe. Sleeves shall be constructed with integral collar or cold side shall be fitted with a bonded slip-on flange or extended collar.

In the case of masonry penetrations where sleeve is not cast-in, voids shall be filled with latex mixed mortar cast to shape of sleeve and flange/external collar type sleeve shall be assembled with butyl elastomer vapor barrier sealant through penetration to cold side surface vapor barrier overlap and fastened to surface with masonry anchors.

Integral cast-in collar type sleeve shall be flashed with not less than [4 inches](#) of cold side vapor barrier overlap of sleeve surface. Normally noninsulated penetrating round surfaces shall be sealed to sleeve bore with mechanically expandable seals in vapor tight manner and remaining warm and cold side sleeve depth shall be insulated with not less than [4 inches](#) of foamed-in-place rigid polyurethane or foamed-in-place silicone elastomer.

Vapor barrier sealant shall be applied to finish warm side insulation surface. Warm side of penetrating surface shall be insulated beyond vapor barrier sealed sleeve insulation for a distance which prevents condensation. Wires in refrigerated space surface penetrating conduit shall be sealed with vapor barrier plugs or compound to prevent moisture migration through conduit and condensation therein.

3.1.13.2 General Service Areas

Each sleeve shall extend through its respective wall, floor, or roof, and shall be cut flush with each surface. Pipes passing through concrete or masonry wall or concrete floors or roofs shall be provided with pipe sleeves fitted into place at the time of construction. Sleeves shall be of such size as to provide a minimum of **1/4 inch** all-around clearance between bare pipe and sleeves or between jacketed-insulation and sleeves. Except in pipe chases or interior walls, the annular space between pipe and sleeve or between jacket over-insulation and sleeve shall be sealed in accordance with Section **07 92 00 JOINT SEALANTS**.

3.1.13.3 Waterproof Penetrations

Pipes passing through roof or floor waterproofing membrane shall be installed through a **.17 ounce** copper sleeve, or a **0.032 inch** thick aluminum sleeve, each within an integral skirt or flange.

Flashing sleeve shall be suitably formed, and skirt or flange shall extend not less than **8 inches** from the pipe and be set over the roof or floor membrane in a troweled coating of bituminous cement. The flashing sleeve shall extend up the pipe a minimum of **2 inches** above the roof or floor penetration. The annular space between the flashing sleeve and the bare pipe or between the flashing sleeve and the metal-jacket-covered insulation shall be sealed as indicated. Penetrations shall be sealed by either one of the following methods.

- a. Waterproofing Clamping Flange: Pipes up to and including **10 inches** in diameter passing through roof or floor waterproofing membrane may be installed through a cast iron sleeve with caulking recess, anchor lugs, flashing clamp device, and pressure ring with brass bolts. Waterproofing membrane shall be clamped into place and sealant shall be placed in the caulking recess.
- b. Modular Mechanical Type Sealing Assembly: In lieu of a waterproofing clamping flange, a modular mechanical type sealing assembly may be installed. Seals shall consist of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe/conduit and sleeve with corrosion protected carbon steel bolts, nuts, and pressure plates. Links shall be loosely assembled with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and each nut.

After the seal assembly is properly positioned in the sleeve, tightening of the bolt shall cause the rubber sealing elements to expand and provide a watertight seal between the pipe/conduit and the sleeve. Each seal assembly shall be sized as recommended by the manufacturer to fit the pipe/conduit and sleeve involved. The Contractor electing to use the modular mechanical type seals shall provide sleeves of the proper diameters.

3.1.13.4 Fire-Rated Penetrations

Penetration of fire-rated walls, partitions, and floors shall be sealed as specified in Section **07 84 00 FIRESTOPPING**.

3.1.13.5 Escutcheons

Finished surfaces where exposed piping, bare or insulated, pass through floors, walls, or ceilings, except in boiler, utility, or equipment rooms, shall be provided with escutcheons. Where sleeves project slightly from floors, special deep-type escutcheons shall be used. Escutcheon shall be secured to pipe or pipe covering.

3.1.14 Access Panels

Access panels shall be provided where indicated for all concealed valves, vents, controls, and additionally for items requiring inspection or maintenance. Access panels shall be of sufficient size and located so that the concealed items may be serviced and maintained or completely removed and replaced. Access panels shall be as specified in Section 08 31 00 ACCESS DOORS AND PANELS.

3.2 ELECTRICAL INSTALLATION

Install electrical equipment in accordance with NFPA 70 and manufacturers instructions.

3.3 CLEANING AND ADJUSTING

Pipes shall be cleaned free of scale and thoroughly flushed of all foreign matter. A temporary bypass shall be provided for all water coils to prevent flushing water from passing through coils. Strainers and valves shall be thoroughly cleaned. Prior to testing and balancing, air shall be removed from all water systems by operating the air vents. Temporary measures, such as piping the overflow from vents to a collecting vessel shall be taken to avoid water damage during the venting process. Air vents shall be plugged or capped after the system has been vented. Control valves and other miscellaneous equipment requiring adjustment shall be adjusted to setting indicated or directed.

3.4 FIELD TESTS

Field tests shall be conducted in the presence of the QC Manager or his designated representative to verify systems compliance with specifications. Any material, equipment, instruments, and personnel required for the test shall be provided by the Contractor.

3.4.1 Equipment and Component Isolation

Prior to testing, equipment and components that cannot withstand the tests shall be properly isolated.

3.4.2 Pressure Tests

Each piping system, except for polypropylene piping, shall be hydrostatically tested at a pressure not less than 188 psig for period of time sufficient to inspect every joint in the system and in no case less than 2 hours. Test pressure shall be monitored by a currently calibrated test pressure gauge. Leaks shall be repaired and piping retested until test requirements are met. No leakage or reduction in gage pressure shall be allowed.

Leaks shall be repaired by rewelding or replacing pipe or fittings. Caulking of joints will not be permitted. Concealed and insulated piping

shall be tested in place before concealing.

Submit for approval [pressure tests reports](#) covering the above specified piping pressure tests; describe the systems tested, test results, defects found and repaired, and signature of the pressure tests' director. Obtain approval from the QC Manager before concealing piping or applying insulation to tested and accepted piping.

3.4.3 Related Field Inspections and Testing

3.4.3.1 Piping Welds

Examination of Piping Welds is specified in the paragraph EXAMINATION OF PIPING WELDS (above).

3.4.3.2 HVAC TAB

Requirements for testing, adjusting, and balancing (TAB) of HVAC water piping, and associated equipment is specified in Section [23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC](#). Coordinate with the TAB team, and provide support personnel and equipment as specified in Section [23 05 93 TESTING, ADJUSTING AND BALANCING FOR HVAC](#) to assist TAB team to meet the TAB work requirements.

3.5 INSTRUCTION TO GOVERNMENT PERSONNEL

Furnish the services of competent instructors to give full instruction to the designated Government personnel in the adjustment, operation, and maintenance, including pertinent safety requirements, of the chilled-hot water,. Instructors shall be thoroughly familiar with all parts of the installation and shall be instructed in operating theory as well as practical operation and maintenance work. Submit a [lesson plan for the instruction course](#) for approval. The lesson plan and instruction course shall be based on the approved operation and maintenance data and maintenance manuals.

Conduct a training course for the operating staff and maintenance staff selected by the Contracting Officer. Give the instruction during the first regular work week after the equipment or system has been accepted and turned over to the Government for regular operation. The number of man-days (8 hours per day) of instruction furnished shall be one man-day.. Use approximately half of the time for classroom instruction and the other time for instruction at the location of equipment or system.

When significant changes or modifications in the equipment or system are made under the terms of the contract, provide additional instruction to acquaint the operating personnel with the changes or modifications.

-- End of Section --

SECTION 23 73 13.00 40

MODULAR INDOOR CENTRAL-STATION AIR-HANDLING UNITS
05/17

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL, INC. (AMCA)

- AMCA 99 (2016) Standards Handbook
- AMCA 211 (2013; Rev 2017) Certified Ratings Program
Product Rating Manual for Fan Air
Performance
- AMCA 300 (2014) Reverberant Room Method for Sound
Testing of Fans

AIR-CONDITIONING, HEATING AND REFRIGERATION INSTITUTE (AHRI)

- AHRI 430 I-P (2014) Performance Rating of Central
Station Air-handling Unit Supply Fans

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING
ENGINEERS (ASHRAE)

- ASHRAE 51 (2016) Laboratory Methods of Testing Fans
for Aerodynamic Performance Rating
- ASHRAE 52.2 (2012) Method of Testing General
Ventilation Air-Cleaning Devices for
Removal Efficiency by Particle Size

ASTM INTERNATIONAL (ASTM)

- ASTM A653/A653M (2022) Standard Specification for Steel
Sheet, Zinc-Coated (Galvanized) or
Zinc-Iron Alloy-Coated (Galvannealed) by
the Hot-Dip Process
- ASTM B117 (2019) Standard Practice for Operating
Salt Spray (Fog) Apparatus

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

- ISO 21940-11 (2016) Mechanical vibration -- Rotor
balancing -- Part 11: Procedures and
Tolerances for Rotors with Rigid Behavior

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

- NFPA 90A (2021) Standard for the Installation of

Air Conditioning and Ventilating Systems

UNDERWRITERS LABORATORIES (UL)

UL 900

(2015; Reprint Aug 2022) UL Standard for
Safety Standard for Air Filter Units

1.2 SUBMITTALS

Government approval is required for submittals. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Installation Drawings; G

Fabrication and Connection Drawings; G

SD-03 Product Data

Equipment and Performance Data; G

Sample Warranty; G

Air Filter Gauges; G

SD-04 Samples

Coating Specimen; G

SD-06 Test Reports

Final Test Reports; G

SD-07 Certificates

List of Product Installations

Certificates of Conformance; G

Unit Cabinet

Fan

Drain Pans

Insulation

Plenums

Spare Parts

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals

SD-11 Closeout Submittals

Warranty

1.3 QUALITY CONTROL

Submit a [list of product installations](#) for air-handling units showing a minimum of five installed units, similar to those proposed for use, that have been in successful service for at least 5 years. Provide a list that includes the purchaser, address of installation, service organization, and date of installation.

1.3.1 Certification of Conformance

Submit [certificates of conformance](#) for the following items, showing conformance with the referenced standards contained in this section:

- a. Unit Cabinet
- b. Fan
- c. Drain Pans
- d. Insulation
- e. Plenums
- h. Spare Parts

1.3.2 Sample Warranty

Submit samples of warranty language concurrently with Certificates for review and approval by the Contracting Officer.

Submit a [sample warranty](#) for the following items:

- a. Unit Cabinet
- b. Fan
- c. Drain Pans
- d. Insulation
- e. Plenums
- h. Spare Parts

1.4 DELIVERY, STORAGE, AND HANDLING

Deliver, handle, and store equipment and accessories in a manner that prevents damage or deformity. Provide temporary skids under units weighing more than [200 pounds](#).

1.5 WARRANTY

Final acceptance is dependent upon providing the warranty, based on approved sample warranty, to the Contracting Officer, along with final test reports. Ensure that the warranty is valid for at least 5 years from the date of project closeout, showing Government as the warranty recipient.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

Submit [equipment and performance data](#) for air-handling units, including use life, total static pressure and coil face area classifications, and performance ratings.

Submit all required [fabrication and connection drawings](#) and obtain approval from the Contracting Officer before the start of work shown on these drawings.

Submit drawings and manuals that include a [spare parts](#) data sheet, with manufacture's recommended stock levels.

2.2 COMPONENTS

2.2.1 Air-Handling Unit (AHU)

Provide a central-station type, factory-fabricated, and sectionally assembled AHU. Provide AHU that includes components and auxiliaries in accordance with [AHRI 430 I-P](#). Balance the AHU fan and motor according to [ISO 21940-11](#).

Ensure that the total static pressure and coil face area classification conforms to [AMCA 99](#).

Fans with enlarged outlets are not permitted.

2.2.2 [Unit Cabinet](#)

2.2.2.1 Class A and Class B Cabinets

Provide an AHU cabinet suitable for the pressure class shown and has leaktight joints, closures, penetrations, and access provisions. Provide a cabinet that does not expand or contract perceptibly when fans are starting or stopping and that does not pulsate during operation. Reinforce cabinet surfaces with deflections in excess of 0.004167 of unsupported span before acceptance. Stiffen pulsating panels, which produce low-frequency noise due to diaphragming of unstable panel walls, to raise the natural frequency to an easily attenuated level. Fabricate the enclosure from continuous hot-dipped-galvanized steel no lighter than [20 gauge](#) thickness, to match the industry standard. Provide mill-galvanized sheet-metal that conforms to [ASTM A653/A653M](#) and that is coated with not less than [1.25 ounces of zinc per square foot](#) of a two-sided surface. Provide mill-rolled structural-steel that is hot-dip-galvanized or primed and painted. Corrosion-protect cut edges, burns, and scratches in galvanized surfaces. Provide primed and painted black carbon steel cabinet construction that complies with this specification.

Provide removable panels to access the interior of the unit cabinet. Provide seams that are welded, bolted, or gasketed and sealed with a rubber-based mastic. Make entire cabinet floor and ceiling hot-dipped-galvanized steel. Provide removable access doors on both sides of all access, filter, and fan sections for inspection and maintenance.

2.2.2.2 Cabinet Construction

Where the cabinet size is such that personnel access is possible, strengthen the cabinet floor to permit entry without damaging any component. Hinge and latch the access doors and panels sufficiently close together to preclude leaks caused by distortion, and effectively gasket.

Black carbon steel cabinet construction is acceptable when the following conditions are met:

- a. Coat all interior and exterior surfaces, including the lapped contacting surfaces, with a corrosion-protective coating.
- b. Certify the coating as passing a 500-hour-exposure salt-spray fog test in accordance with [ASTM B117](#).
- c. Immediately after completing the test, provide a [coating specimen](#) that shows no signs of wrinkling, cracking, or loss of adherence and no signs of rust creep beyond [1/8 inch](#) on either side of the scratch mark.
- d. Ensure that inspection of interior and exterior cabinet surfaces will pass examination for the same defects as the salt-spray fog test specimen, after 11 months of service and before the guarantee expires.

Interior surfaces of cabinets that are constructed of intact mill-galvanized steel require no further protection.

Provide cabinets with exterior surfaces constructed of mill-galvanized-steel that are painted .

Provide cabinets and casings that are double-walled with [2 inch](#) insulation. Provide a galvanized interior wall.

Weigh the fan and motor assembly at the AHU manufacturer's factory for isolator selection. Statically and dynamically balance fan section assemblies, including fan wheels, shafts, bearings, drives, belts, isolation bases, and isolators. Allow isolators to free-float when performing fan balance. Measure vibration at each fan shaft bearing in horizontal, vertical, and axial directions.

Factory install all motors on slide bases to permit adjustment of belt tension.

Provide heavy-duty, open drip-proof, three-phase fan motors, operable at [208/460](#) volts (V), 60 hertz (Hz). Provide high-efficiency motors.

Provide a marine-type, vapor-proof service light in the fan segment. Provide a [L.E.D Equivalent](#) to 100 watt (W) service light that is wired to an individual switch and operates on 115 V, single-phase, 60 Hz service that is separate from the main power to the AHU. Provide a single 115 V outlet at the light switch.

2.2.3 [Fan](#)

[Provide a direct drive fan array](#). Mount fans on isolation bases. Internally mount motors on the same isolation bases and internally isolate

fans and motors. Install flexible canvas ducts or a vibration absorbent fan discharge seal between the fan and casings to ensure complete isolation. Provide flexible canvas ducts that comply with NFPA 90A.

Provide an overall fan-section depth that is equal to or greater than the manufacturer's free-standing fan.

2.2.4 Drain Pans

Provide intermediate-coil, 3 inch deep drip pans for each tiered coil bank.

Extend the top pan 12 inches beyond the face of the coil, and extend the bottom pan not less than 24 inches beyond the face of the coil. Where more than two pans are used, make the pan extension proportional. Make adequate supports from the same type of material as the pans or from hot-dip galvanized angle iron with isolation at the interface. Use 22-gauge, AISI Type 304, corrosion-resistant steel for pan material, with silver-soldered joints. Minimum size of the drain opening is 1-1/4 inches. Pipe the pan to the drain.

Extend the integral cabinet drain pan under all areas where condensate is collected and make it watertight with welded or brazed joints, piped to the drain. Provide corrosion protection in condensate collection areas, and insulate against sweating. Provide minimum 14-gauge sheet metal; however 16-gauge double-drain-pan construction is also acceptable.

Provide cooling coil ends that are enclosed by the cabinet and are factory insulated against sweating or drain to a drain pan.

Provide drain pans that are double-pan construction, thermally isolated from the exterior casing with 1 inch thick fiberglass insulation. Provide drain pans that slope to the drain and drain substantially dry by gravity alone when the drains are open.

Provide pans that have a double slope to the drain point.

2.2.5 Insulation

Provide a unit that is internally fitted at the factory with a sound-attenuating, thermal-attenuating, fibrous-glass material not less than 2 inches thick. Ensure that the insulation precludes any condensation on any exterior cabinet surface under conditions that are normal to the unit's installed location. Provide acoustic treatment that attenuates fan noise in compliance with specified noise criteria. Apply material to the entire cabinet with waterproof adhesives and permanent fasteners. Provide adhesive and insulating material in accordance with NFPA 90A.

2.2.6 Plenums

Provide plenums in the following minimum widths:

- a. 6 inches for mounting temperature controls and to separate two or more coils of different size that are mounted in series
- b. 14 inches between face and bypass dampers and upstream accessories and at change in cross-section

c. 24 inches for access sections

2.2.7 Coils

2.2.7.1 Coil Section

Provide a coil section that encases cooling coils and drain pipes. Arrange coils for horizontal air flow. Provide intermediate drain pans for multiple-coils installation. Completely enclose coil headers with the insulated casing with only the connections extending through the cabinet.

2.2.7.2 Coil Pressure and Temperature Ratings

Ensure that the coils are designed for the following fluid operating pressures and temperatures:

<u>SERVICE</u>	<u>PRESSURE</u>	<u>TEMPERATURE</u>
Hot Water	200 PSI	250 degrees F
Chilled Water	200 PSI	40 degrees F

Provide coils that are air-pressure-tested under water at the following minimum pressures:

<u>SERVICE</u>	<u>PRESSURE</u>
Water (hot and chilled)	250 PSI

2.2.7.3 Coil Casings

Provide coils that are factory-tested, dehydrated, vacuum-tested, purged with inert gas, and sealed before shipped to the job site.

Provide stainless-steel casings. Provide cast iron, brass, or copper coil headers. Fit water coil headers with 0.25 inch ips spring-loaded plug drains and vent petcocks. Provide automatic air vents with ball-type isolation valves for each coil that is piped to the drain pan.

2.2.7.4 Chilled Water Coils

Provide 0.625 inch outside diameter copper tubing for coils. Provide fins that are copper and mechanically bonded by tubing expansion with a maximum spacing of 12 fins per 1 inch unless otherwise noted. Provide coils that have supply and return connections on the same end. Provide a maximum of four coil rows.

2.2.7.5 Hot Water Coils

Provide heating coils that have copper tubing copper fins.

2.2.7.6 Drainable Coils

Provide drainable coils that are capable of being purged free of water with compressed air.

2.2.8 Eliminators

Provide eliminators that are SMACNA three-break, hooked-edge design, constructed of reinforced 16 gauge galvanized steel with assembled brazed joints. Provide easily removable eliminator sections for cleaning from the side of the AHU without requiring partial or complete disassembly of the AHU casing.

2.2.9 Filters

2.2.9.1 Filter Housing

Provide factory-fabricated filter sections of the same construction and finish as the unit casings. Provide filter sections that have filter guides and full height, double-wall, hinged, and removable access doors for filter removal. Provide air sealing gaskets to prevent air bypass around filters. Provide visible identification on media frames showing the model number and airflow direction. Where a filter bank is indicated or required, provide a means of sealing to prevent bypass of unfiltered air. Ensure that the filters perform in accordance with ASHRAE 52.2.

2.2.9.2 Replaceable Air Filters

Select filters conforming to UL 900, Class 1. Ensure that when clean filters are exposed to flame, the filters do not contribute fuel when attacked by flame and emit only negligible amount of smoke. Provide permanent frames with replaceable media, 1 inch thickness, size as indicated.

2.2.9.3 Disposable Cartridge Air Filters

Provide UL 900, Class 2, UL-classified, and factory-assembled filters. Provide media of ultra-fine glass fibers having 50 to 55 percent average dust spot efficiencies with a maximum final resistance 0.75-inch water gauge, and maximum face velocity of 500 feet per minute. Construct filter frames of 18 gauge galvanized steel or aluminum with welded or riveted joints. Caulk or gasket the entire assembly to prevent air leakage around the frames. Ensure that the minimum efficiency of the filter is 60 percent per ASHRAE 52.2.

2.2.9.4 Air Filter Gauges

Provide manometer air filter gauges of the inclined tube differential type that have solid acrylic plastic construction with a built-in level vial and with an adjustable mirror-polished scale. Equip gauges with vent valves for zeroing and over-pressure safety traps. Ensure that the gauge range is adequate for the particular installation.

Provide one air filter gauge at each filter bank.

PART 3 EXECUTION

3.1 PREPARATION

Coordinate the size and location of concrete equipment pads, variable frequency drives, control, and electrical requirements.

3.2 INSTALLATION

Install equipment in accordance with the manufacturer's recommendations.

Provide [installation drawings](#) in accordance with referenced standards in this section.

3.2.1 Temporary Construction Filters

Have temporary construction filters in place during normal building construction whenever the AHUs are run for general ventilation, building dehumidification, or other purposes during construction. Install two layers of blanket filter at a time. Replace temporary construction filters as required during construction and after duct system cleaning is completed.

After systems have been cleaned and temporary construction filters are removed, and before test and balance operations are started, install a set of final filters. Avoid loading the filter with construction dust; do not have final filters in place while general building construction is taking place. Clean the permanent filter bank before testing and balancing.

3.3 FIELD QUALITY CONTROL

3.3.1 Vibration Analyzer

Use an Fast Fourier Transform (FFT) analyzer to measure vibration levels. The following characteristics are required: A dynamic range greater than 70 dB; a minimum of 400-line resolution; a frequency response range of 5 Hz to 10 KHz(300-600000 cpm); the capacity to perform ensemble averaging, the capability to use a Hanning window; auto-ranging frequency amplitude; a minimum amplitude accuracy over the selected frequency range of plus or minus 20 percent or plus or minus 1.5 dB.

Use an accelerometer, either stud-mounted or mounted using a rare earth, low-mass magnet and sound disk (or finished surface) with the FFT analyzer to collect data. Ensure that the mass of the accelerometer and its mounting have minimal influence on the frequency response of the system over the selected measurement range.

3.3.2 Acceptance

Before final acceptance, use dial-indicator gauges to demonstrate that the fan and motor are aligned as specified.

Before final acceptance, verify conformance to specifications using vibration analysis. Ensure that the maximum vibration levels are [0.075 inches per second](#) at 1 times run speed and at fan/blade frequency, and [0.04 inches per second](#) at other multiples of run speed.

3.3.3 AHU Testing

Conduct performance test and rate the AHU and components in accordance with [AMCA 211](#), [AMCA 300](#), and [ASHRAE 51](#). Provide AHU ratings in accordance with [AHRI 430 I-P](#).

Provide **final test reports** to the Contracting Officer. Provide reports with a cover letter/sheet clearly marked with the system name, date, and the words "Final Test Reports - Forward to the Systems Engineer/Condition Monitoring Office/Predictive Testing Group for inclusion in the Maintenance Database."

Perform AHU start-up in the presence of the Contracting Officer.

3.4 CLOSEOUT ACTIVITIES

3.4.1 Operation And Maintenance

Submit **operation and maintenance manuals** before testing the AHUs. Update and resubmit data for final approval no later than 30 calendar days before contract completion.

3.4.2 Spare Parts

Provide 1 set of replacement filters for each air handler unit. Submit to the Contracting Officer for maintenance use.

3.4.3 Acceptance

With the warranty, provide a cover letter/sheet clearly marked with the system name, date, and the words "Equipment Warranty" - "Forward to the Systems Engineer/Condition Monitoring Office/Predictive Testing Group for inclusion in the Maintenance Database."

-- End of Section --

SECTION 23 81 00

DECENTRALIZED UNITARY HVAC EQUIPMENT
05/18, CHG 1: 02/21

PART 1 GENERAL

1.1 RELATED REQUIREMENTS

Section 23 03 00.00 20 BASIC MECHANICAL MATERIALS AND METHODS, applies to this section with the additions and modifications specified herein.

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AIR-CONDITIONING, HEATING AND REFRIGERATION INSTITUTE (AHRI)

AHRI 700 (2016) Specifications for Fluorocarbon Refrigerants

ANSI/AHRI 210/240 (2008; Add 1 2011; Add 2 2012) Performance Rating of Unitary Air-Conditioning & Air-Source Heat Pump Equipment

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ANSI/ASHRAE 15 & 34 (2013) ANSI/ASHRAE Standard 15-Safety Standard for Refrigeration Systems and ANSI/ASHRAE Standard 34-Designation and Safety Classification of Refrigerants

ASHRAE 15 & 34 (2013) ASHRAE Standard 34-2016 Safety Standard for Refrigeration Systems/ASHRAE Standard 34-2016 Designation and Safety Classification of Refrigerants-ASHRAE Standard 34-2016

ASHRAE 52.2 (2012) Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size

ASHRAE 55 (2017) Thermal Environmental Conditions for Human Occupancy

ASHRAE 62.1 (2016) Ventilation for Acceptable Indoor Air Quality

ASHRAE 90.1 - IP (2019; Errata 1 2019; Errata 2-5 2020; Addenda BY-CP 2020; Addenda AF-DB 2020; Addenda A-G 2020; Addenda F-Y 2021; Errata 6-8 2021; Interpretation 1-4 2020; Interpretation 5-8 2021 Addenda AS-AQ

2022) Energy Standard for Buildings Except
Low-Rise Residential Buildings

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME BPVC SEC IX	(2017; Errata 2018) BPVC Section IX-Welding, Brazing and Fusing Qualifications
ASME BPVC SEC VIII D1	(2019) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1

AMERICAN WELDING SOCIETY (AWS)

AWS Z49.1	(2021) Safety in Welding and Cutting and Allied Processes

ASTM INTERNATIONAL (ASTM)

ASTM B117	(2019) Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM C1071	(2019) Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material)
ASTM D520	(2000; R 2011) Zinc Dust Pigment
ASTM E84	(2020) Standard Test Method for Surface Burning Characteristics of Building Materials

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(2021) Motors and Generators
NEMA MG 2	(2014) Safety Standard for Construction and Guide for Selection, Installation and Use of Electric Motors and Generators

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-DTL-5541	(2006; Rev F) Chemical Conversion Coatings on Aluminum and Aluminum Alloys

UNDERWRITERS LABORATORIES (UL)

UL 1995	(2015; Reprint Aug 2022) UL Standard for Safety Heating and Cooling Equipment

1.3 SUBMITTALS

Government approval is required for submittals. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Spare Parts

Posted Instructions

Coil Corrosion Protection

Training; G

Inventory

Supplied Products

Manufacturer's Standard Catalog Data

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals; G

SD-11 Closeout Submittals

Ozone Depleting Substances; S

1.4 QUALITY ASSURANCE

Carefully investigate the plumbing, fire protection, electrical, structural and finish conditions that would affect the work to be performed and arrange such work accordingly, furnishing required offsets, fittings, and accessories to meet such conditions. Submit drawings consisting of:

- a. Equipment layouts which identify assembly and installation details.
- b. Plans and elevations which identify clearances required for maintenance and operation.
- c. Wiring diagrams which identify each component individually and interconnected or interlocked relationships between components.
- d. Foundation drawings, bolt-setting information, and foundation bolts prior to concrete foundation construction for equipment indicated or required to have concrete foundations.
- e. Details, if piping and equipment are to be supported other than as indicated, which include loadings and type of frames, brackets, stanchions, or other supports.
- f. Automatic temperature control diagrams and control sequences.
- g. Installation details which includes the amount of factory set superheat and corresponding refrigerant pressure/temperature.
- h. Equipment schedules

1.5 DELIVERY, STORAGE, AND HANDLING

Protect stored items from the weather, humidity and temperature variations, dirt and dust, or other contaminants. Properly protect and care for all material both before and during installation. Submit an [inventory](#) of all the stored items. Replace any materials found to be damaged, at no additional cost to the Government. During installation, cap piping and similar openings capped to keep out dirt and other foreign

matter.

1.6 ENVIRONMENTAL REQUIREMENTS

For proper Indoor Environmental Quality, maintain pressure within the building as indicated. Ventilation must meet or exceed [ASHRAE 62.1](#) and all published addenda. Meet or exceed filter media efficiency as tested in accordance with [ASHRAE 52.2](#). Thermal comfort must meet or exceed [ASHRAE 55](#).

1.7 WARRANTY

Provide equipment with the Manufacturer's Standard Warranty.

PART 2 PRODUCTS

2.1 ENERGY EFFICIENCY REQUIREMENTS

42 USC 8259b requires the procurement of energy efficient products in product categories covered by the Energy Star program or the Federal Energy Management Program for designated products. A list of covered product categories is available from the Federal Energy Management Web site at <http://energy.gov/eere/femp/covered-product-categories>.

Submit Material, Equipment, and Fixtures List of all [supplied products](#) within a covered product category, including manufacturer's catalog numbers, specification and drawing reference number, warranty information, fabrication site, and energy performance data. For product categories covered by the Federal Energy Management Program, submit documentation that the product meets or exceeds FEMP-designated efficiency requirements.

2.2 MATERIALS

Provide [Manufacturer's standard catalog data](#), at least 5 weeks prior to the purchase or installation of a particular component, highlighted to show material, size, options, performance charts and curves, etc. in adequate detail to demonstrate compliance with contract requirements. Data includes manufacturer's recommended installation instructions and procedures. If vibration isolation is specified for a unit, include vibration isolator literature containing catalog cuts and certification that the isolation characteristics of the isolators provided meet the manufacturer's recommendations. Submit data for each specified component. Minimum efficiency requirements must be in accordance with [ASHRAE 90.1 - IP](#).

2.2.1 Standard Products

Provide materials and equipment that are standard products of a manufacturer regularly engaged in the manufacturing of such products, which are of a similar material, design and workmanship. The standard products must have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2 year use includes applications of equipment and materials under similar circumstances and of similar size. The 2 years' experience must be satisfactorily completed by a product which has been sold or is offered for sale on the commercial market through advertisements, manufacturer's catalogs, or brochures. Products having less than a 2 year field service record will be acceptable if a certified record of satisfactory field operation, for not less than 6000

hours exclusive of the manufacturer's factory tests, can be shown. Products must be supported by a service organization. Ensure system components are environmentally suitable for the indicated geographic locations.

2.2.2 Product Sustainability Criteria

2.2.2.1 Energy Efficient Equipment

Provide equipment meeting the efficiency requirements as stated within this section and provide documentation.

2.2.2.2 Electrical Equipment / Motors

Provide electrical equipment, motors, motor efficiencies, and wiring which are in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Electrical motor driven equipment specified must be provided complete with motors, motor starters, and controls. Electrical characteristics must be as shown, and unless otherwise indicated, all motors of 1 horsepower and above with open, dripproof, totally enclosed, or explosion proof fan cooled enclosures, must be the premium efficiency type in accordance with NEMA MG 1. Field wiring must be in accordance with manufacturer's instructions. Each motor must conform to NEMA MG 1 and NEMA MG 2 and be of sufficient size to drive the equipment at the specified capacity without exceeding the nameplate rating of the motor. Motors must be continuous duty with the enclosure specified. Motor starters must be provided complete with thermal overload protection and other appurtenances necessary for the motor control indicated. Motors must be furnished with a magnetic across-the-line or reduced voltage type starter as required by the manufacturer. Motor duty requirements must allow for maximum frequency start-stop operation and minimum encountered interval between start and stop. Motors must be sized for the applicable loads. Motor torque must be capable of accelerating the connected load within 20 seconds with 80 percent of the rated voltage maintained at motor terminals during one starting period. Motor bearings must be fitted with grease supply fittings and grease relief to outside of enclosure. Manual or automatic control and protective or signal devices required for the operation specified and any control wiring required for controls and devices specified, but not shown, must be provided.

2.2.2.3 Ozone Depleting Substances

Unitary air conditioning equipment must not use CFC-based refrigerants. Refrigerant may be an approved alternative refrigerant in accordance with EPA's Significant New Alternative Policy (SNAP) listing. Provide documentation

2.2.2.4 Local/Regional Materials

Use materials or products extracted, harvested, or recovered, as well as manufactured, within a 500 mile radius from the project site, if available from a minimum of three sources.

2.2.3 Nameplates

Major equipment including compressors, condensers, receivers, heat

exchanges, fans, and motors must have the manufacturer's name, address, type or style, model or serial number, and catalog number on a plate secured to the item of equipment. Plates must be durable and legible throughout equipment life and made of anodized aluminum. Fix plates in prominent locations with nonferrous screws or bolts.

2.2.4 Safety Devices

Exposed moving parts, parts that produce high operating temperature, parts which may be electrically energized, and parts that may be a hazard to operating personnel must be insulated, fully enclosed, guarded, or fitted with other types of safety devices. Safety devices must be installed so that proper operation of equipment is not impaired. Welding and cutting safety requirements must be in accordance with [AWS Z49.1](#).

2.3 EQUIPMENT

2.3.1 Mini-Split-System Air Conditioners Heat Pumps

2.3.1.1 Small-Capacity Split-System Air-Conditioners (Not Exceeding [65,000 Btu/hr](#))

Provide an air-cooled, split system which employs a remote condensing unit, a separate ceiling mounted indoor unit, and interconnecting refrigerant piping. Provide the heat pump type unit conforming to applicable Underwriters Laboratories (UL) standards including [UL 1995](#). Unit must be rated in accordance with [ANSI/AHRI 210/240](#). Provide indoor unit with necessary fans, air filters, and galvanized steel cabinet construction. The remote unit must be as specified in paragraph CONDENSING UNIT. Provide double-width, double inlet, forward curved backward inclined, or airfoil blade, centrifugal scroll type evaporator or supply fans. Provide the manufacturer's standard condenser or outdoor fans for the unit specified and may be propeller type. Fan and condenser motors must have open [or](#) drip proof enclosures. Design unit to operate at outdoor ambient temperatures up to [115 degrees F](#).

2.3.1.1.1 Energy Efficiency

Provide unit with an Energy Star label. Air Conditioners must have a minimum seasonal energy efficiency ratio (SEER) of [20](#), and a minimum COP of [4.4](#).

2.3.1.1.2 Air-to-Refrigerant Coil

Provide condensing coils with copper tubes of [3/8 inch](#) minimum diameter with aluminum fins that are mechanically bonded or soldered to the tubes. Casing must be galvanized steel. Avoid contact of dissimilar metals. Test coils in accordance with [ASHRAE 15 & 34](#) at the factory and ensure suitability for the working pressure of the installed system. Dehydrate and seal each coil testing and prior to evaluation and charging.

Coat condenser coil with a uniformly applied epoxy electrodeposition type coating to all coil surface areas without material bridging between fins. Apply coating at either the coil or coating manufacturer's factory. Coating process must ensure complete coil encapsulation and be capable of withstanding a minimum 1,000 hours exposure to the salt spray test specified in [ASTM B117](#) using a 5 percent sodium chloride solution.

2.3.1.1.3 Compressor

Provide direct drive digital scroll type compressor. Provide compressor with internal over temperature and pressure protector; sump heater; oil pump; high pressure and low pressure controls; and liquid line dryer.

2.3.1.1.4 Refrigeration Circuit

Refrigerant-containing components must comply with [ASHRAE 15 & 34](#) and be factory tested, cleaned, dehydrated, charged, and sealed. Provide each unit with a factory operating charge of refrigerant and oil or a holding charge. Field charge unit shipped with a holding charge. Provide refrigerant charging valves. Provide filter-drier in liquid line to prevent freeze-up in event of loss of water flow during heating cycle.

2.3.1.1.5 Unit Controls

Provide unit internally prewired with a 24 volt control circuit powered by an internal transformer. Provide terminal blocks for power wiring and external control wiring. Internally protect unit by fuses or a circuit breaker in accordance with [UL 1995](#). Equip units with three-phase power with phase monitoring protection to protect against problems caused by phase loss, phase imbalance and phase reversal. Provide unit with microprocessor controls to provide all 24V control functions.

2.3.1.1.6 Condensing Coil

Provide coils with copper tubes of [3/8 inch](#) minimum diameter with aluminum fins that are mechanically bonded or soldered to the tubes. Protect coil in accordance with paragraph CORROSION PROTECTION. Provide galvanized steel or aluminum casing. Avoid contact of dissimilar metals. Test coils in accordance with [ANSI/ASHRAE 15 & 34](#) at the factory and ensure suitability for the working pressure of the installed system. Dehydrate and seal each coil after testing and prior to evaluation and charging. Provide separate expansion devices for each compressor circuit.

2.3.1.1.7 Remote Condenser or Condensing Unit

Fit each remote condenser coil fitted with a manual isolation valve and an access valve on the coil side. Saturated refrigerant condensing temperature must not exceed [120 degrees F](#) at [104 degrees F](#) ambient. Provide unit with low ambient condenser controls to ensure proper operation in an ambient temperature of [20 degrees F](#). Provide fan and cabinet construction as specified in paragraph UNITARY EQUIPMENT ACCESSORIES. Fan and condenser motors must have totally enclosed enclosures.

2.3.1.1.8 Air Filters

Provide filters of the cleanable type that are capable of filtering the entire air supply. Mount filter(s) integral within the unit and make accessible by hinged access panel(s). [1 inch](#) MERV 7, provide throwaway filter on all units below [6 Tons](#).

2.3.1.1.9 Fans

Provide direct driven, statically and dynamically balanced, centrifugal type fans. Design the outdoor fan so that condensate will evaporate without drip, splash, or spray on building exterior. Provide indoor fan

with a minimum two-speed motor with built-in overload protection. Fan motors must be the inherently protected, permanent split-capacitor type.

2.4 COMPONENTS

2.4.1 Refrigerant and Oil

Refrigerant must be one of the fluorocarbon gases. Refrigerants must have number designations and safety classifications in accordance with [ASHRAE 15 & 34](#). Refrigerants must meet the requirements of [AHRI 700](#) as a minimum. Provide a complete charge of refrigerant for the installed system as recommended by the manufacturer. Lubricating oil must be of a type and grade recommended by the manufacturer for each compressor. Where color leak indicator dye is incorporated, charge must be in accordance with manufacturer's recommendation.

2.4.2 Fans

Fan wheel shafts must be supported by either maintenance-accessible lubricated antifriction block-type bearings, or permanently lubricated ball bearings. Unit fans must be selected to produce the [cfm](#) required at the fan total pressure. Thermal overload protection must be of the manual or automatic-reset type. Fan wheels or propellers must be constructed of aluminum or galvanized steel. Centrifugal fan wheel housings must be of galvanized steel, and both centrifugal and propeller fan casings must be constructed of aluminum or galvanized steel. Steel elements of fans, except fan shafts, must be hot-dipped galvanized after fabrication or fabricated of mill galvanized steel. Mill-galvanized steel surfaces and edges damaged or cut during fabrication by forming, punching, drilling, welding, or cutting must be recoated with an approved zinc-rich compound. Fan wheels or propellers must be statically and dynamically balanced. Forward curved fan wheels must be limited to [1 inches](#). Direct-drive fan motors must be of the multiple-speed variety. Each drive will be independent of any other drive. Propeller fans must be direct-drive drive type with fixed pitch blades. Each drive will be independent of any other drive. Drive bearings must be protected with water slingers or shields.

2.4.3 Cabinet Construction

Casings for the specified unitary equipment must be constructed of galvanized steel or aluminum sheet metal and galvanized or aluminum structural members. Minimum thickness of single wall exterior surfaces must be [18 gauge](#) galvanized steel or [0.071 inch](#) thick aluminum on units with a capacity above [20 tons](#) and [20 gauge](#) galvanized steel or [0.064 inch](#) thick aluminum on units with a capacity less than [20 tons](#). Casing must be fitted with lifting provisions, access panels or doors, fan vibration isolators, electrical control panel, corrosion-resistant components, structural support members, insulated condensate drip pan and drain, and internal insulation in the cold section of the casing. Where double-wall insulated construction is proposed, minimum exterior galvanized sheet metal thickness must be [20 gauge](#). Provisions to permit replacement of major unit components must be incorporated. Penetrations of cabinet surfaces, including the floor, must be sealed. Unit must be fitted with a drain pan which extends under all areas where water may accumulate. Drain pan must be fabricated from Type 300 stainless steel, galvanized steel with protective coating as required, or an approved plastic material. Pan insulation must be water impervious. Extent and effectiveness of the insulation of unit air containment surfaces must prevent, within limits of

the specified insulation, heat transfer between the unit exterior and ambient air, heat transfer between the two conditioned air streams, and condensation on surfaces. Insulation must conform to [ASTM C1071](#). Paint and finishes must comply with the requirements specified in paragraph FACTORY COATING.

2.4.3.1 Indoor Cabinet

Indoor cabinets must be suitable for the specified indoor service and enclose all unit components.

2.4.3.2 Outdoor Cabinet

Outdoor cabinets must be suitable for outdoor service with a weathertight, insulated and corrosion-protected structure. Cabinets constructed exclusively for indoor service which have been modified for outdoor service are not acceptable.

2.4.4 Refrigerant Piping

Provide refrigerant piping in accordance with Section [23 23 00](#) REFRIGERANT PIPING.

2.4.6 Temperature Controls

Provide temperature controls in accordance with Section [23 09 23.02](#) BACnet DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS.

2.5 FINISHES

2.5.1 Coil Corrosion Protection

Provide coil with a uniformly applied epoxy electrodeposition type coating to all coil surface areas without material bridging between fins. Submit product data on the type coating selected, the coating thickness, the application process used, the estimated heat transfer loss of the coil, and verification of conformance with the salt spray test requirement. Coating must be applied at either the coil or coating manufacturer's factory. Coating process must ensure complete coil encapsulation. Coating must be capable of withstanding a minimum 1,000 hours exposure to the salt spray test specified in [ASTM B117](#) using a 5 percent sodium chloride solution.

2.5.2 Equipment and Components Factory Coating

Unless otherwise specified, equipment and component items, when fabricated from ferrous metal, must be factory finished with the manufacturer's standard finish, except that items located outside of buildings must have weather resistant finishes that will withstand 500 hours exposure to the salt spray test specified in [ASTM B117](#) using a 5 percent sodium chloride solution. Immediately after completion of the test, the specimen must show no signs of blistering, wrinkling, cracking, or loss of adhesion and

no sign of rust creepage beyond $1/8$ inch on either side of the scratch mark. Cut edges of galvanized surfaces where hot-dip galvanized sheet steel is used must be coated with a zinc-rich coating conforming to ASTM D520, Type I.

Where stipulated in equipment specifications of this section, coat finned tube coils of the affected equipment as specified below. Apply coating at the premises of a company specializing in such work. Degrease and prepare for coating in accordance with the coating applicator's procedures for the type of metals involved. Completed coating must show no evidence of softening, blistering, cracking, crazing, flaking, loss of adhesion, or "bridging" between the fins.

2.5.2.1 Chemical Conversion Coating with Polyelastomer Finish Coat

Dip coils in a chemical conversion solution to molecularly deposit a corrosion resistant coating by electrolysis action. Chemical conversion coatings must conform to MIL-DTL-5541, Class 1A. Cure conversion coating at a temperature of 110 to 140 degrees F for a minimum of 3 hours. Coat coil surfaces with a complex polymer primer with a dry film thickness of 1 mil. Cure primer coat for a minimum of 1 hour. Using dip tank method, provide three coats of a complex polyelastomer finish coat. After each of the first two finish coats, cure the coils for 1 hour. Following the third coat, spray a fog coat of an inert sealer on the coil surfaces. Total dry film thickness must be 2.5 to 3.0 mils. Cure finish coat for a minimum of 3 hours. Coating materials must have 300 percent flexibility, operate in temperatures of minus 50 to plus 220 degrees F, and protect against atmospheres of a pH range of 1 to 14.

2.5.3 Factory Applied Insulation

Refrigeration equipment must be provided with factory installed insulation on surfaces subject to sweating including the suction line piping. Where motors are the gas-cooled type, factory installed insulation must be provided on the cold-gas inlet connection to the motor in accordance with manufacturer's standard practice. Factory insulated items installed outdoors are not required to be fire-rated. As a minimum, factory insulated items installed indoors must have a flame spread index no higher than 75 and a smoke developed index no higher than 150. Factory insulated items (no jacket) installed indoors and which are located in air plenums, in ceiling spaces, and in attic spaces must have a flame spread index no higher than 25 and a smoke developed index no higher than 50. Flame spread and smoke developed indexes must be determined by ASTM E84. Insulation must be tested in the same density and installed thickness as the material to be used in the actual construction. Material supplied by a manufacturer with a jacket must be tested as a composite material. Jackets, facings, and adhesives must have a flame spread index no higher than 25 and a smoke developed index no higher than 50 when tested in accordance with ASTM E84.

2.6 TESTS, INSPECTIONS, AND VERIFICATIONS

All manufactured units must be inspected and tested, and documentation provided to demonstrate that each unit is in compliance with ANSI/AHRI and UL requirements and that the minimum efficiency requirements of ASHRAE 90.1 - IP have been met.

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with all details of the work, perform Verification of Dimensions in the field, and advise the Contracting Officer of any discrepancy before performing any work.

3.2 INSTALLATION

Perform work in accordance with the manufacturer's published diagrams, recommendations, and equipment warranty requirements. Where equipment is specified to conform to the requirements of ASME BPVC SEC VIII D1 and ASME BPVC SEC IX, the design, fabrication, and installation of the system must conform to ASME BPVC SEC VIII D1 and ASME BPVC SEC IX.

3.2.1 Equipment

Provide refrigeration equipment conforming to ASHRAE 15 & 34. Provide necessary supports for all equipment, appurtenances, and pipe as required, including frames or supports for compressors, pumps, cooling towers, condensers, and similar items. Equipment must be properly leveled, aligned, and secured in place in accordance with manufacturer's instructions.

3.2.2 Mechanical Room Ventilation

Provide mechanical ventilation systems in accordance with Section 23 30 00 HVAC AIR DISTRIBUTION.

3.3 CLEANING AND ADJUSTING

Equipment must be wiped clean, with all traces of oil, dust, dirt, or paint spots removed. Temporary filters must be provided for all fans that are operated during construction, and new filters must be installed after all construction dirt has been removed from the building. System must be maintained in this clean condition until final acceptance. Bearings must be properly lubricated with oil or grease as recommended by the manufacturer. Belts must be tightened to proper tension. Control valves and other miscellaneous equipment requiring adjustment must be adjusted to setting indicated or directed. Fans must be adjusted to the speed indicated by the manufacturer to meet specified conditions. Testing, adjusting, and balancing must be as specified in Section 23 05 93 TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS.

3.4 TRAINING

Conduct a training course for the operating staff as designated by the Contracting Officer. The training period must consist of a total 8 hours of normal working time and start after the system is functionally completed but prior to final acceptance tests.

- a. Submit a schedule, at least 2 weeks prior to the date of the proposed training course, which identifies the date, time, and location for the training.
- b. Submit the field posted instructions, at least 2 weeks prior to construction completion, including equipment layout, wiring and control diagrams, piping, valves and control sequences, and typed

condensed operation instructions. The condensed operation instructions must include preventative maintenance procedures, methods of checking the system for normal and safe operation, and procedures for safely starting and stopping the system. The posted instructions must be framed under glass or laminated plastic and be posted where indicated by the Contracting Officer.

- c. The posted instructions must cover all of the items contained in the approved [operation and maintenance manuals](#) as well as demonstrations of routine maintenance operations. Submit 6 complete copies of an operation manual in bound [8-1/2 by 11 inch](#) booklets listing step-by-step procedures required for system startup, operation, abnormal shutdown, emergency shutdown, and normal shutdown at least 4 weeks prior to the first training course. The booklets must include the manufacturer's name, model number, and parts list. The manuals must include the manufacturer's name, model number, service manual, and a brief description of all equipment and their basic operating features.
- d. Submit 6 complete copies of maintenance manual in bound [8-1/2 by 11 inch](#) booklets listing routine maintenance procedures, possible breakdowns and repairs, and a trouble shooting guide. The manuals must include piping and equipment layouts and simplified wiring and control diagrams of the system as installed.

3.5 MAINTENANCE

3.5.1 EXTRA MATERIALS

Submit [spare parts](#) data for each different item of equipment specified, after approval of detail drawings and not later than 2 months prior to the date of beneficial occupancy. Include in the data a complete list of parts and supplies, with current unit prices and source of supply, a recommended spare parts list for 1 year of operation, and a list of the parts recommended by the manufacturer to be replaced on a routine basis.

-- End of Section --

SECTION 23 82 16.00 40

AIR COILS
08/22

PART 1 GENERAL

Section 23 30 00 HVAC AIR DISTRIBUTION applies to work specified in this section.

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AIR-CONDITIONING, HEATING AND REFRIGERATION INSTITUTE (AHRI)

AHRI 410 (2001; Addendum 1 2002; Addendum 2 2005; Addendum 3 2011) Forced-Circulation Air-Cooling and Air-Heating Coils

ASTM INTERNATIONAL (ASTM)

ASTM A653/A653M (2022) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

ASTM B43 (2020) Standard Specification for Seamless Red Brass Pipe, Standard Sizes

ASTM B88 (2022) Standard Specification for Seamless Copper Water Tube

1.2 SUBMITTALS

Government approval is required for submittals. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Record of Existing Conditions

SD-02 Shop Drawings

Fabrication Drawings

Connection Diagrams

Controls Layout

Internal Tubing and Wiring

Installation Drawings

SD-03 Product Data

Hot-Water Heating

Chilled-Water Cooling

SD-05 Design Data

Design Analysis and Calculations

SD-06 Test Reports

Final Test Reports

SD-07 Certificates

Certificates of Conformance

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals

SD-11 Closeout Submittals

Record Drawings

1.3 QUALITY CONTROL

Submit a **record of existing conditions** consisting of the results of a survey of work area conditions and features of existing structures and facilities within and adjacent to the jobsite.

Provide coils that bear the ARI certification seal indicating compliance with **AHRI 410**. Submit **Certificates of Conformance** for following items showing conformance with **AHRI 410**:

- a. Coil
- b. Coil casings
- c. Coil headers
- d. Coil tubing
- e. Coil circuiting

Indicate the general physical **controls layout**, and **internal tubing and wiring** details on the drawings. Submit **design analysis and calculations** for coils.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

Submit manufacturer's catalog data for the following coil types indicating, when applicable, coil pressure and temperature ratings, coil casings, headers, tubing, circuiting, and drainable coils.

- a. **Hot-water heating**
- b. **Chilled-water cooling**

Submit [fabrication drawings](#) for coil units consisting of fabrication and assembly details to be performed in the factory. Include [connection diagrams](#) indicating the relations and connections of the following items:

- a. Coil
- b. Coil casings
- c. Coil headers
- d. Coil tubing
- e. Coil circuiting

2.1.1 Coil Pressure and Temperature Ratings

Provide coils designed for the following fluid operating pressures and temperatures:

Service	Pressure (psi)	Temperature (Degrees F)
Hot water	200	250
Chilled water	200	45

Air-pressure test coils under water at the following minimum pressures:

Service	Pressure (psi)
Hot water	250
Chilled water	250

2.2 COMPONENTS

2.2.1 Coil Casings

Provide coil casings that are mill-galvanized, [16-gage](#), minimum. Ensure sheet metal has not less than [1.25-ounces of zinc per square foot](#) of two-sided metal surface conforming to [ASTM A653/A653M](#). Provide a casing flanged on four sides for bolted assembly, except as otherwise specified.

Where coils are stacked, provide a double-bend construction casing.

Provide casings with end supports and top and bottom channels of rigid construction that provide allowance for thermal expansion and contraction. Coil supports, channels and blank-off plates shall be the same metal as the coil casing.

Provide duct-mounted reheat coil casings not over [36-inches](#) in length, fabricated from a minimum [20-gage](#) galvanized steel conforming to above specified requirements. Provide casings that are flanged or suitable for drive-slip assembly.

Provide coil mounting within the housing that is either fixed or slide-out type, except as otherwise specified. Provide slide-out type coils for ceiling-suspended package units, and for other package units whose capacity exceeds 15,000 cubic-feet per minute.

2.2.2 Coil Headers

Provide direct expansion, volatile refrigerant coils with necessary control connections.

Fit steam and water coil headers with 1/4-inch iron pipe size(ips) spring-loaded plug drains and vent petcocks. Provide automatic vents where indicated.

2.2.3 Coil Tubing

Install coils constructed of copper tubing with aluminum or copper fins. Provide helical coil fins that are wound tight to the tubes and solder-coated. Provide plate fins that have spacer collars in metallic contact with the adjacent fin. Plate fins shall be continuous. Ensure fins are mechanically bonded to the tube. Ensure bare tube surface is not visible within the finned portion of the coil.

Provide solder-coated cooling coils of helical wound copper design.

For coil tubes in water or volatile refrigerant service, provide tubes that are parallel. Ensure coil tubes have sufficient intermediate full coil depth supports to prevent sagging of unsupported span due to: working fluid pressures, temperatures, and summer and winter coil-ambient conditions. Sagging is unacceptable if tube centerline is displaced by more than 3/16-inch from centerline of tube connection at outlet header when coils are more than two rows deep and when installed in accordance with the manufacturer's instructions. Make adequate provision for expansion and contraction that precludes sagging and distortion under thermal loads applied in indicated or specified service. Slope tubes to be free draining.

Provide maximum heating-coil face tube spacing of 3-inches on center for 1-inch outside-diameter (od) tubes, 2-inches for 3/4-inch od tubes, and 1-1/2-inches for 5/8-inch od tubes.

Provide coil face tube spacing for cooling coils and for helically wound heating coils immediately followed by water-cooling coils that do not exceed 1-1/2-inches on center.

Ensure tubes are straight, with turns made through headers or return U-bends, with brazed connections and joints, except as otherwise specified.

Ensure coil tube material is seamless deoxidized copper.

Ensure coil tube material is seamless 90-10 copper-nickel with 0.035-inch wall thickness for superheated-steam service to 350-pounds per square inch (psi) at 500 degrees F.

Where mechanical insert devices are used to increase liquid turbulence within tubes, increase the wall thickness of these tubes by 0.010-inch over the minimum raw coil tube stock specified for the service.

Provide minimum tube outside diameter of 1/2-inch.

2.2.4 Coil Circuiting

Provide standard or full-circuited water coils that have as many full-length tubes in each circuit as the number of tubes in the depth of the coil face.

Provide counterflow type coils when more than two rows deep, except that in the case of double- or half-circuit coils, reasonable deviation from counterflow arrangement is permitted, provided the pressure drop and capacity requirements are met.

2.2.5 Drainable Coils

Provide drainable coils that are capable of being purged free of water with compressed air.

Provide self-draining coils with a drain point at the end of every tube and sloped to that point. Provide drain provisions that include: drained headers, U-bends with integral plugs; or nonferrous plugs in cast-iron headers. Provide tubes that drain substantially dry by gravity alone when drains and vents are open.

Where necessary, fill the coil with water to the end of the manufacturer's header connections and check drainage volume against the manufacturer's data.

2.2.6 Coil Types

2.2.6.1 Hot-Water Heating

For Type HA, provide continuous circuit type, limited to two rows depth.

For Type HB, provide drainable counterflow type, with more than two rows.

Casings shall be minimum 16-gauge, 304 stainless steel.

Coil headers shall be Type L seamless copper conforming to ASTM B88, with tubes brazed to header.

2.2.6.2 Chilled-Water Cooling

For Type CC, provide self-draining, cleanable, counterflow type. Provide straight-through type tubes, rolled or brazed into steel tube sheets. Enclose headers with gasketed and bolted removable cover plates to provide access to tube internals from either one end or both ends of coil.

Casings shall be minimum 16-gauge, 304 stainless steel.

Coil headers shall be Type L seamless copper conforming to ASTM B88, with tubes brazed to header.

Coil connections shall be Schedule 40 red brass conforming to ASTM B43, threaded end for 2-inch and smaller and flanged end for 2-1/2-inch and larger.

Maximum allowable fin spacing shall be 10 fins per inch. Coil depth shall not exceed 8 rows to allow for the cleaning of the coil in place.

PART 3 EXECUTION

3.1 INSTALLATION

Install coils in accordance with the manufacturer's recommendations.

Submit [installation drawings](#) for coil systems. Indicate overall physical features, dimensions, ratings, service requirements, equipment weights and layout and arrangement details of equipment room on drawings.

Clean oil film from coil fins with hot water/detergent as recommended by coil manufacturer.

Comb out fins when bent or crushed before enclosing coils in housing. Clean dust and debris from each coil to ensure its cleanliness.

Provide offsets in piping and physical space adjacent to the installed coil to facilitate coil removal.

Provide flexible piping connections and/or piping vibration isolation supports where specified or shown.

3.2 FIELD QUALITY CONTROL

For drainable coils:

- a. Field check coil pitch and leveling for drainability in the presence of the Contracting Officer.
- b. Perform pressure tests and dehydrate coils.
- c. Perform vacuum tests, purge with inert gas, and seal coils.

Provide [final test reports](#) to the Contracting Officer. Provide reports with a cover letter/sheet clearly marked with the System name, Date, and the words "Final Test Reports - Forward to the Systems Engineer/Condition Monitoring Office/Predictive Testing Group for inclusion in the Maintenance Database."

3.3 CLOSEOUT ACTIVITIES

3.3.1 Operation and Maintenance

Submit 6 copies of the [operation and maintenance manuals](#) 30 calendar days prior to testing the coil systems. Update and resubmit data for final approval no later than 30 calendar days prior to contract completion.

3.3.2 Record Drawings

Submit [record drawings](#) for coil systems providing current factual information including deviations from, and amendments to, the drawings and concealed and visible changes in the work.

-- End of Section --

SECTION 23 82 46.00 40

ELECTRIC UNIT HEATERS
05/17

PART 1 GENERAL

Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM applies to work specified in this section.

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

UNDERWRITERS LABORATORIES (UL)

UL 1996 (2009; Reprint Aug 2022) UL Standard for
Safety Electric Duct Heaters

1.2 ADMINISTRATIVE REQUIREMENTS

1.2.1 Preinstallation Meetings

The Contracting Officer will schedule a preinstallation meeting within 30 days of Contract Award. Provide the following for review and approval:

- a. Submit fabrication drawings for electric heaters, indicating the fabrication and assembly details to be performed in the factory.
- b. Submit manufacturer's instructions for electric heaters, stating the special provisions necessary to install equipment components and system packages. Detail the impedances, hazards and safety precautions within the special notices.

1.3 SUBMITTALS

Government approval is required for submittals. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Fabrication Drawings

SD-03 Product Data

Performance Data

Electric Unit Heaters

Heating Element

Controls

Casings

Propellers and Motors

SD-08 Manufacturer's Instructions

Manufacturer's Instructions

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

Provide suspended electric unit heaters, and arrange for the discharge of air as indicated.

Provide electric unit heaters with at least the indicated capacity and ensure that they conform to the requirements specified herein. Ensure that the electric unit heaters are factory-prewired and ready for field terminal connections.

Ensure products conform to the requirements of **UL 1996** for **electric unit heaters**.

Submit **performance data** for electric heaters, including use life, test, system functional flows, safety features, and mechanical automated details.

2.2 COMPONENTS

2.2.1 Heating Element

Provide a heating element constructed of a resistance wire insulated by highly compacted refractory insulation protected by a sealed metallic-finned sheath. Provide component materials as follows:

- a. Provide a resistance wire of not less than 20-helix wound alloy of approximately 80-percent nickel and 20-percent chromium.
- b. Provide a refractory insulation of magnesium oxide with a resistance of not less than 50,000 ohms after exposure to an ambient temperature and humidity of **90 degrees F** and 85 plus or minus 5-percent relative humidity, respectively, for not less than 24 hours.
- c. Provide a sheathing consisting of aluminum fins cast around an internal steel sheath containing refractory insulation and resistance wire or carbon-steel fins permanently attached to a tubular carbon-steel sheath containing refractory insulation and resistance wire and with external surfaces porcelainized.

Ensure that the maximum surface temperature of porcelain-protected steel sheathing is **700 degrees F**.

2.2.2 Controls

Fit units up to and including 5 kilowatts with integral controls, including thermal overload cutout switches, necessary transformers, a liquid-vapor system, and low-mass bimetal thermostat as required. Provide a cutout switch that can be automatically reset.

Provide wall-mounted thermostats complete with thermometer, mechanical high-limit stop, calibrated operator, and an adjustable heater to prevent override of space temperature with a range between **55 and 105 degrees F** and a differential not exceeding **1.5 degrees F**. Provide a thermostat

rated for operation at 24 volts, 60 hertz. Provide transformers, wiring, and devices necessary to meet this requirement. Provide a casing finish in brushed chrome .

2.2.3 Propellers and Motors

Provide propellers with mill-aluminized blades statically and dynamically balanced to within 0.5 percent. Provide units with fan-inlet safety guards.

Ensure that propellers and motors are AMCA-certified for air performance and noise level.

Protect motors against damage by the heating element and resilient mount.

Subfractional and fractional custom-designed or applied motors may deviate from the preceding motor requirements as follows:

- a. Shaded-pole motors rated less than 1/6 horsepower may be used for direct-drive service.
- b. Permanent split-capacitor, split-phase, and capacitor-start motors rated 1/4 horsepower or less may be used for direct-drive service.
- c. Split-phase and capacitor-start motors, rated 1/4 horsepower or less, may be used for belt-drive service.
- d. Motor bearings may be the manufacturer's standard prelubricated sleeve type but provide the motor with antifriction thrust bearings, when specified. Ensure that the lubricant provisions are for extended service, requiring replenishment not more than twice per year of continuous operation.

Provide the manufacturer's standard motor identification plate.

Provide the manufacturer's standard motor speed and control.

PART 3 EXECUTION

3.1 INSTALLATION

Install unit heaters in accordance with the manufacturer's instructions at the mounting heights indicated.

3.1.1 Casings

Provide casings with smoothly contoured propeller orifice rings of at least 20-gage cold-rolled carbon steel. Provide a casing surface finish with phosphate pretreatment, prime coating, and baked-enamel finish.

3.1.2 Air Distribution

Provide horizontal units with adjustable single- or double-deflection

louvers.

3.2 FIELD QUALITY CONTROL

Demonstrate in the presence of the Contracting Officer that the unit heaters operate satisfactorily.

Cycle unit heaters five times, from start to operating thermal conditions to off, to verify adequacy of construction, system controls, and component performance.

Conduct an operational test for a minimum of 6 hours.

-- End of Section --

SECTION 26 05 00.00 40

COMMON WORK RESULTS FOR ELECTRICAL
11/20

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D709 (2017) Standard Specification for
Laminated Thermosetting Materials

ELECTRONIC INDUSTRIES ALLIANCE (EIA)

EIA 480 (1981) Toggle Switches

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE Stds Dictionary (2009) IEEE Standards Dictionary: Glossary
of Terms & Definitions

INTERNATIONAL CODE COUNCIL (ICC)

ICC/ANSI A117.1 (2009) Accessible and Usable Buildings and
Facilities

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI C80.1 (2020) American National Standard for
Electrical Rigid Steel Conduit (ERSC)

ANSI C80.3 (2020) American National Standard for
Electrical Metallic Tubing (EMT)

ANSI Z535.1 (2017) Safety Colors

ANSI/NEMA OS 1 (2013; R 2020) Sheet-Steel Outlet Boxes,
Device Boxes, Covers, and Box Supports

NEMA 250 (2020) Enclosures for Electrical Equipment
(1000 Volts Maximum)

NEMA AB 3 (2013) Molded Case Circuit Breakers and
Their Application

NEMA FB 1 (2014) Standard for Fittings, Cast Metal
Boxes, and Conduit Bodies for Conduit,
Electrical Metallic Tubing, and Cable

NEMA FU 1 (2012) Low Voltage Cartridge Fuses

NEMA ICS 1 (2000; R 2015) Standard for Industrial

Control and Systems: General Requirements

NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures
NEMA KS 1	(2013) Enclosed and Miscellaneous Distribution Equipment Switches (600 V Maximum)
NEMA PB 1	(2011) Panelboards
NEMA RN 1	(2005; R 2013) Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit
NEMA TC 2	(2020) Standard for Electrical Polyvinyl Chloride (PVC) Conduit
NEMA TC 3	(2021) Polyvinyl Chloride (PVC) Fittings for Use With Rigid PVC Conduit and Tubing
NEMA WD 1	(1999; R 2020) Standard for General Color Requirements for Wiring Devices
NEMA WD 6	(2016) Wiring Devices Dimensions Specifications

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2020; ERTA 20-1 2020; ERTA 20-2 2020; ERTA 20-3 2020; TIA 20-1; TIA 20-2; TIA 20-3; TIA 20-4; TIA 20-5; TIA 20-6; TIA 20-7; TIA 20-8; TIA 20-9; TIA 20-10; TIA 20-11; TIA 20-12; TIA 20-13; TIA 20-14; TIA 20-15; TIA 20-16; ERTA 20-4 2022) National Electrical Code
NFPA 70E	(2021) Standard for Electrical Safety in the Workplace

UNDERWRITERS LABORATORIES (UL)

UL 1	(2005; Reprint Jan 2020) UL Standard for Safety Flexible Metal Conduit
UL 5	(2016; Reprint Aug 2020) UL Standard for Safety Surface Metal Raceways and Fittings
UL 6	(2007; Reprint Sep 2019) UL Standard for Safety Electrical Rigid Metal Conduit-Steel
UL 20	(2018; Reprint Jan 2021) UL Standard for Safety General-Use Snap Switches
UL 50	(2015) UL Standard for Safety Enclosures for Electrical Equipment, Non-Environmental Considerations
UL 67	(2018; Reprint Jul 2020) UL Standard for

Safety Panelboards

UL 83	(2017; Reprint Mar 2020) UL Standard for Safety Thermoplastic-Insulated Wires and Cables
UL 198M	(2018) UL Standard for Mine-Duty Fuses
UL 360	(2013; Reprint Aug 2021) UL Standard for Safety Liquid-Tight Flexible Metal Conduit
UL 486A-486B	(2018; Reprint May 2021) UL Standard for Safety Wire Connectors
UL 486C	(2018; Reprint May 2021) UL Standard for Safety Splicing Wire Connectors
UL 489	(2016; Rev 2019) UL Standard for Safety Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures
UL 498	(2017; Reprint Sep 2021) UL Standard for Safety Attachment Plugs and Receptacles
UL 514A	(2013; Reprint Aug 2017) UL Standard for Safety Metallic Outlet Boxes
UL 514B	(2012; Reprint May 2020) Conduit, Tubing and Cable Fittings
UL 514C	(2014; Reprint Feb 2020) UL Standard for Safety Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers
UL 651	(2011; Reprint May 2022) UL Standard for Safety Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings
UL 797	(2007; Reprint Mar 2021) UL Standard for Safety Electrical Metallic Tubing -- Steel
UL 869A	(2006; Reprint Jun 2020) Reference Standard for Service Equipment
UL 870	(2016; Reprint Mar 2019) UL Standard for Safety Wireways, Auxiliary Gutters, and Associated Fittings
UL 943	(2016; Reprint Feb 2018) UL Standard for Safety Ground-Fault Circuit-Interrupters
UL 1242	(2006; Reprint Apr 2022) UL Standard for Safety Electrical Intermediate Metal Conduit -- Steel
UL 1449	(2021) UL Standard for Safety Surge Protective Devices
UL 4248-1	(2022) UL Standard for Safety Fuseholders

- Part 1: General Requirements

UL 4248-12

(2018) UL Standard for Safety Fuseholders
- Part 12: Class R

1.2 DEFINITIONS

- a. Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, are as defined in IEEE Stds Dictionary.
- b. The technical sections referred to herein are those specification sections that describe products, installation procedures, and equipment operations and that refer to this section for detailed description of submittal types.

1.3 SUBMITTALS

Government approval is required for submittals . Submit the following in accordance with the design build contractor's SATOC Task Order:

SD-02 Shop Drawings

Marking Strips; SD-03 Product Data

Conduits and Raceways

Wire and Cable

Splices and Connectors

Switches

Receptacles

Outlet Boxes, Pull Boxes and Junction Boxes

Circuit Breakers

Panelboards

Device Plates

SD-06 Test Reports

Continuity Test

Phase-Rotation Tests

Insulation Resistance Test

600-Volt Wiring Test

Insulation-Resistance Test

SD-08 Manufacturer's Instructions

Manufacturer's Instructions

1.4 QUALITY CONTROL

1.4.1 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Ensure equipment, materials, installation, and workmanship are in accordance with the mandatory and advisory provisions of NFPA 70, unless more stringent requirements are specified or indicated.

1.4.2 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Provide products which have been in satisfactory commercial or industrial use for 2 years prior to bid opening. Ensure the 2-year period includes applications of equipment and materials under similar circumstances and of similar size. Ensure the product has been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Where two or more items of the same class of equipment are required, these items must be products of a single manufacturer.

PART 2 PRODUCTS

2.1 EQUIPMENT

Provide the standard cataloged materials and equipment of manufacturers regularly engaged in the manufacture of the products. For material, equipment, and fixture lists submittals, show manufacturer's style or catalog numbers, specification and drawing reference numbers, warranty information, and fabrication site.

Provide factory-applied finish on electrical equipment in accordance with the following:

- a. NEMA 250 corrosion-resistance test and the additional requirements as specified herein.
- b. Interior and exterior steel surfaces of equipment enclosures: thoroughly cleaned followed by a rust-inhibitive phosphatizing or equivalent treatment prior to painting.
- c. Exterior surfaces: free from holes, seams, dents, weld marks, loose scale or other imperfections.
- d. Interior surfaces: receive not less than one coat of corrosion-resisting paint in accordance with the manufacturer's standard practice.
- e. Exterior surfaces: primed, filled where necessary, and given not less than two coats baked enamel with semigloss finish.
- f. Equipment located indoors: ANSI Light Gray.
- g. Provide manufacturer's coatings for touch-up work and as specified in

paragraph FIELD APPLIED PAINTING.

2.1.1 Conduits and Raceways

2.1.1.1 Rigid Steel Conduit

Provide hot dipped galvanized rigid steel conduit complying with NEMA RN 1, ANSI C80.1, UL 6 and UL 5 as applicable. Except where installed underground, or in corrosive areas, provide polyvinylchloride (PVC), or protect from corrosion by painting with bitumastic coating or wrapping with corrosion inhibiting tape..

Use threaded fittings for rigid steel conduit.

Use solid gaskets. Ensure conduit fittings with blank covers have gaskets, except in clean, dry areas or at the lowest point of a conduit run where drainage is required.

Provide covers with captive screws and are accessible after the work has been completed.

2.1.1.2 Electrical Metallic Tubing (EMT)

Ensure EMT is in accordance with UL 797, UL 5, and ANSI C80.3 and is zinc coated steel. Provide zinc-coated couplings and connectors that are raintight, gland compression type with insulated throat. Crimp, spring, or setscrew type fittings are not acceptable.

2.1.1.3 Flexible Metallic Conduit

Ensure flexible metallic conduit is galvanized steel and complies with UL 1 and UL 360.

Ensure fittings for flexible metallic conduit are specifically designed for such conduit.

Provide liquidtight flexible metallic conduit with a protective jacket of PVC extruded over a flexible interlocked galvanized steel core to protect wiring against moisture, oil, chemicals, and corrosive fumes.

Ensure fittings for liquidtight flexible metallic conduit are specifically designed for such conduit.

2.1.1.4 Intermediate Metal Conduit

Ensure intermediate metal conduit is galvanized steel and complies with UL 1242, NEMA RN 1, ANSI C80.1, UL 6 and UL 5 as applicable.

2.1.1.5 Rigid Nonmetallic Conduit

Ensure rigid nonmetallic conduit complies with NEMA TC 2, NEMA TC 3, and UL 651 as applicable with a wall thickness not less than Schedule 40.

2.1.2 Wireways

Ensure wireways and auxiliary gutters are a minimum 4 by 4-inch trade size conforming to UL 870.

UL 870. Material: steel galvanized 16 gauge for heights and depths up to

6 by 6 inches, and 14 gauge for heights and depths up to 12 by 12 inches. Provide in length required for the application with hinged- cover NEMA1 enclosure per NEMA ICS 6.

2.1.3 Outlet Boxes, Pull Boxes and Junction Boxes

Ensure outlet boxes for use with conduit systems are in accordance with NEMA FB 1 UL 514A, UL 514B, UL 514C and ANSI/NEMA OS 1 and are not less than 1-1/2 inches deep. Furnish all pull and junction boxes with screw-fastened covers.

2.1.4 Panelboards

Provide panelboards in accordance with NEMA PB 1, UL 67, and UL 50. Ensure panelboards for use as service equipment are also in accordance with UL 869A. Ensure panelboards have current rating, number of phases, and number of wires as indicated or specified herein. Ensure panelboards are rated for 240-volt (maximum), single-phase, 120/208-volt, three-phase or 277/480-volt, three-phase, 60-hertz as required. Ensure each panelboard, as a complete unit, has a short-circuit current rating equal to or greater than the integrated equipment rating indicated, but in no case less than 10,000 amperes symmetrical.

Provide panelboards with bolt-on circuit breakers only. Use of plug-in style breaker is not permitted. Ensure panelboards are designed such that individual breakers can be removed without disturbing adjacent units or without loosening or removing supplemental insulation supplied as means of obtaining required clearance. Provide main lugs or main circuit breakers mounted "above" or "below" as field conditions dictate. All branch breakers shall indicate current ratings. Use of sub-feed breakers is not acceptable unless specifically indicated otherwise. Where "space only" is indicated, make provisions for future installation of breakers.

Submit detail drawings and manufacturer's standard product data for panelboards. Detail drawings consist of fabrication and assembly drawings for all parts of the work in sufficient detail to verify conformity with all requirements. Ensure drawings for panelboards indicate details of bus layout, overall physical features, dimensions, ratings, service requirements, and weights of equipment.

Provide copper buses of the rating indicated, with main lugs or main circuit breaker. Provide all panelboards for use on grounded ac systems with a separate grounding bus in accordance with UL 67 bonded to the panelboard enclosure. Ensure grounding bus is a solid bus bar of rectangular cross section equipped with binding screws for the connection of equipment grounding conductors. Provide three-phase, four-wire and single-phase, three-wire panelboards with an isolated full-capacity bus providing spaces for single-pole circuit breaker switches and spaces indicated as spare.

Provide bus bar connections to the branch circuit breakers that are the "distributed phase" or "phase sequence" type. Ensure single-phase, three-wire panelboard busing is such that when any two adjacent single-pole breakers are connected to opposite phases, two-pole breakers can be installed in any location. Ensure that three-phase, four-wire panelboard busing is such that when any three adjacent single-pole breakers are individually connected to each of the three different phases, two- or three-pole breakers can be installed at any location. Ensure current-carrying parts of the bus assembly are plated.

Support bus bars on bases independent of circuit breakers. Design main buses and back pans so that breakers may be changed without machining, drilling, or tapping.

2.1.4.1 Circuit Breakers

Provide circuit breakers that conform to [UL 489](#) and [NEMA AB 3](#).

Provide bolt-on type, molded-case, manually operated, trip-free circuit breakers, with inverse-time thermal-overload protection and instantaneous magnetic short-circuit protection. Completely enclose circuit breakers in a molded case, with a factory-sealed, calibrated sensing element to prevent tampering. Plug-in type, tandem, and half-size circuit breakers are not permitted.

Provide inverse-time-delay thermal-overload protection and instantaneous magnetic short-circuit protection. Provide circuit breakers with frame sizes 250 ampere and larger with solid-state trip units equipped with adjustable long-time, short-time and ground-fault settings in addition to instantaneous.

Provide sufficient interrupting capacity of the panel and lighting branch circuit breakers to successfully interrupt the maximum short-circuit current imposed on the circuit at the breaker terminals. Provide circuit breaker interrupting capacities with a minimum of 10,000 A and that conform to [NEMA AB 3](#). Series rating of circuit breakers or overcurrent protective devices to achieve indicated interrupt rating is not permitted.

Provide the common-trip-type multipole circuit breakers having a single operating handle and a two-position on/off indication. Provide circuit breakers with temperature compensation for operation in an ambient temperature of [104 degrees F](#). Provide circuit breakers that have root mean square (rms) symmetrical interrupting ratings sufficient to protect the circuit being supplied. Interrupting ratings may have selective-type tripping (time delay, magnetic, thermal, or ground fault).

Provide a phenolic-composition breaker body capable of having such accessories as handle-extension, handle-locking, and padlocking devices attached where required to meet lock-out/tag-out requirements of [NFPA 70E](#).

2.2 MATERIALS

2.2.1 Wire And Cable

Provide wires and cables in accordance applicable requirements of [NFPA 70](#) and [UL](#) for type of insulation, jacket, and conductor specified or indicated. Do not use wires and cables manufactured more than 12 months prior to date of delivery to site.

Provide minimum conductor size in accordance with the following:

- a. Branch circuits: No. 12 AWG.
- b. Class 1 remote-control and signal circuits: No. 14 AWG.
- c. Class 2 low-energy, remote-control and signal circuits: No. 16 AWG.
- d. Class 3 low-energy, remote-control, alarm and signal circuits: No. 22

AWG.

Ensure connectors used in wire systems comply with [UL 486A-486B](#) and [UL 486C](#) as applicable.

Ensure conductors installed in plenums are marked plenum rated.

2.2.1.1 Insulation

Unless specified or indicated otherwise or required by [NFPA 70](#), provide power and lighting wires rated for 600-volts, Type THWN/THHN conforming to [UL 83](#), except that grounding wire may be type TW conforming to [UL 83](#); remote-control and signal circuits: Type TW or TF, conforming to [UL 83](#). Where lighting fixtures require 90-degree Centigrade (C) conductors, provide only conductors with 90-degree C insulation or better.

2.2.2 Device Plates

Provide the following:

- a. UL listed, one-piece device plates for outlets to suit the devices installed.
- b. For metal outlet boxes, plates on unfinished walls: zinc-coated sheet steel or cast metal having round or beveled edges.
- c. For nonmetallic boxes and fittings, other suitable plates may be provided.
- e. Plates on finished walls: satin finish stainless steel or brushed-finish aluminum, minimum [0.03 inch](#) thick.
- f. Screws: machine-type with countersunk heads in color to match finish of plate.
- g. Sectional type device plates are not be permitted.
- h. Plates installed in wet locations: gasketed and UL listed for "wet locations."

2.2.3 Switches

2.2.3.1 Safety Switches

Ensure safety switches comply with [NEMA KS 1](#), and are the heavy-duty type with enclosure, voltage, current rating, number of poles, and fusing as indicated on the drawings. Ensure fused switch fuse holders comply with [UL 4248-1](#). Ensure switch construction is such that, when the switch handle in the "ON" position, the cover or door cannot be opened. Cover release device is coinproof and so constructed that an external tool is used to open the cover. Make provisions to lock the handle in the "OFF" position. Ensure the switch is not capable of being locked in the "ON" position.

Provide switches of the quick-make, quick-break type and terminal lugs for use with copper conductors.

Ensure safety color coding for identification of safety switches conforms to [ANSI Z535.1](#).

2.2.3.2 Toggle Switches

Ensure toggle switches comply with [EIA 480](#), [NEMA WD 1](#), and [UL 20](#) control Light Emitting Diode (LED), and fluorescent lighting fixtures and are the heavy duty, general purpose, noninterchangeable flush-type.

Provide commercial grade toggle switches, single-pole, three -way two-position devices rated 20 amperes at 120/277 volts, 60 hertz alternating current (ac) only.

Ensure all toggle switches are products of the same manufacturer.

2.2.4 Fuses

[NEMA FU 1](#). Provide complete set of fuses for each fusible switch. Coordinate time-current characteristics curves of fuses serving motors or connected in series with circuit breakers for proper operation. Submit coordination data for approval. Provide fuses with a voltage rating not less than circuit voltage.

2.2.4.1 Fuseholders

Provide in accordance with [UL 4248-1](#).

2.2.4.2 Cartridge, Current Limiting Type (Class R)

[UL 198M](#), Class RK-5 time-delay type. Provide only Class R associated fuseholders in accordance with [UL 4248-12](#).

2.2.4.3 Cartridge Fuses, High-Interrupting Capacity, Current Limiting Type (Classes J, L, and CC)

[UL 198M](#), Class J for zero to 600 amperes, Class L for 601 to 6,000 amperes, and Class CC for zero to 30 amperes.

2.2.4.4 Cartridge Fuses, Current Limiting Type (Class T)

[UL 198M](#), Class T for zero to 1,200 amperes, 300 volts; and zero to 800 amperes, 600 volts.

2.2.5 Receptacles

Provide the following:

- a. [UL 498](#), hard use (also designated heavy-duty), grounding-type.
- b. Ratings and configurations: as indicated.
- c. Bodies: [gray](#) as per [NEMA WD 1](#).
- d. Face and body: thermoplastic supported on a metal mounting strap.
- e. Dimensional requirements: per [NEMA WD 6](#).
- f. Screw-type, side-wired wiring terminals or of the solderless pressure type having suitable conductor-release arrangement.
- g. Grounding pole connected to mounting strap.

- h. The receptacle: containing triple-wipe power contacts and double or triple-wipe ground contacts.

2.2.5.1 Switched Duplex Receptacles

Provide separate terminals for each ungrounded pole. Top receptacle: switched when installed.

2.2.5.2 Weatherproof Receptacles

Provide receptacles, UL listed for use in "wet locations." Include cast metal box with gasketed, hinged, lockable and weatherproof while-in-use, die-cast metal/aluminum cover plate.

2.2.5.3 Ground-Fault Circuit Interrupter Receptacles

UL 943, duplex type for mounting in standard outlet box. Provide device capable of detecting current leak of 6 milliamperes or greater and tripping per requirements of UL 943 for Class A ground-fault circuit interrupter devices. Provide screw-type, side-wired wiring terminals or pre-wired (pigtail) leads.

2.2.5.4 Plugs

Provide heavy-duty, rubber-covered three-,wire cord of required size, install plugs thereon, and attach to equipment. Provide UL listed plugs with receptacles, complete with grounding blades. Where equipment is not available, turn over plugs and cord assemblies to the Government.

2.2.6 Manufacturer's Nameplate

Ensure each item of equipment has a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent is not acceptable.

2.2.7 Warning Signs

Provide warning signs for the enclosures of electrical equipment including substations, pad-mounted transformers, pad-mounted switches, generators, and switchgear having a nominal rating exceeding 600 volts.

2.2.8 Surge Protective Devices

Provide parallel type surge protective devices (SPD) which comply with UL 1449 at the service entrance. Provide surge protectors in a NEMA 1 enclosure per NEMA ICS 6. Use Type 1 or Type 2 SPD and connect on the load side of a dedicated circuit breaker.

Provide the following modes of protection:

FOR SINGLE PHASE AND THREE PHASE WYE CONNECTED SYSTEMS-
Phase to phase (L-L)
Each phase to neutral (L-N)
Neutral to ground (N-G)
Phase to ground (L-G)

SPDs at the service entrance: provide with a minimum surge current rating of 80,000 amperes for L-L mode minimum and 40,000 amperes for other modes (L-N, L-G, and N-G) and downstream SPDs rated 40,000 amperes for L-L mode minimum and 20,000 amperes for other modes (L-N, L-G, and N-G).

Provide SPDs. Maximum L-N, L-G, and N-G Voltage Protection Rating:

700V for 120V, single phase system
700V for 120/240V, single phase system
700V for 208Y/120V, three phase system
1,200V for 480Y/277V, three phase system

The minimum MCOV (Maximum Continuous Operating Voltage) rating for L-N and L-G modes of operation: 120% of nominal voltage for 240 volts and below; 115% of nominal voltage above 240 volts to 480 volts.

PART 3 EXECUTION

3.1 PREPARATION

Submit [manufacturer's instructions](#) including special provisions required to install equipment components and system packages. Special provisions include impedances, hazards and safety precautions.

Clean and paint conduit, supports, fittings, cabinets, pull boxes, and racks..

Protect metallic materials against corrosion. Provide equipment enclosures with the standard finish by the manufacturer when used for most indoor installations. Do not use aluminum when in contact with earth or concrete and, where connected to dissimilar metal, protect by using approved fittings and treatment. Except where other equivalent protective treatment is specifically approved in writing, provide hot-dip galvanized ferrous metals for items such as, anchors, bolts, braces, boxes, bodies, clamps, fittings, guards, nuts, pins, rods, shims, thimbles, washers, and miscellaneous items not made of corrosion-resistant steel.

3.2 INSTALLATION

3.2.1 Underground Service

Underground service conductors and associated conduit: continuous from service entrance equipment to outdoor power system connection.

3.2.2 Service Entrance Identification

Service entrance disconnect devices, switches, and enclosures: labeled and identified as such.

3.2.3 Labels

Wherever work results in service entrance disconnect devices in more than one enclosure, as permitted by [NFPA 70](#), label each enclosure, new and existing, as one of several enclosures containing service entrance disconnect devices. Label, at minimum: indicate number of service disconnect devices housed by enclosure and indicate total number of enclosures that contain service disconnect devices. Provide laminated plastic labels conforming to paragraph FIELD FABRICATED NAMEPLATES. Use

lettering of at least 0.25 inch in height, and engrave on black-on-white matte finish. Service entrance disconnect devices in more than one enclosure: provided only as permitted by NFPA 70.

3.2.4 Wiring Methods

Provide insulated conductors installed in rigid steel conduit, IMC, rigid nonmetallic conduit, or EMT, except where specifically indicated or specified otherwise or required by NFPA 70 to be installed otherwise. Grounding conductor: separate from electrical system neutral conductor. Provide insulated green equipment grounding conductor for circuit(s) installed in conduit and raceways. Minimum conduit size: 1/2 inch in diameter for low voltage lighting and power circuits. Vertical distribution in multiple story buildings: made with metal conduit in fire-rated shafts, with metal conduit extending through shafts for minimum distance of 6 inches. Firestop conduit which penetrates fire-rated walls, fire-rated partitions, or fire-rated floors.

3.2.4.1 Pull Wire

Install pull wires in empty conduits. Pull wire: plastic having minimum 200-pound force tensile strength. Leave minimum 36 inches of slack at each end of pull wire.

3.2.5 Conduits, Raceways and Fittings

Ensure that conduit runs between outlet and outlet, between fitting and fitting, or between outlet and fitting does not contain more than the equivalent of three 90-degree bends, including those bends located immediately at the outlet or fitting.

Do not install crushed or deformed conduit. Avoid trapped conduit runs where possible. Take care to prevent the lodgment of foreign material in the conduit, boxes, fittings, and equipment during the course of construction. Clear any clogged conduit of obstructions or replace conduit.

Conduit and raceway runs concealed in or behind walls, above ceilings, or exposed on walls and ceilings 5 feet or more above finished floors and not subject to mechanical damage may be electrical metallic tubing (EMT).

Unless indicated otherwise, conceal conduit under floor slabs and within finished walls, ceilings, and floors. Keep conduit minimum 6 inches away from parallel runs of flues and steam or hot water pipes. Install conduit parallel with or at right angles to ceilings, walls, and structural members where located above accessible ceilings and where conduit will be visible after completion of project.

3.2.5.1 Rigid Steel Conduit

Make field-made bends and offsets with approved Hickey bending tool or conduit bending machine. Use long radius conduit for elbows larger than 2-1/2 inches.

Provide a flush coupling for all conduit stubbed-up through concrete floors for connections to free-standing equipment with the exception of motor-control centers, cubicles, and other such items of equipment, when the floor slab is of sufficient thickness. Otherwise, provide a floor box set flush with the finished floor. For conduits installed for future use,

terminate with a coupling and plug; set flush with the floor.

3.2.5.2 Electrical Metallic Tubing (EMT)

Ground EMT in accordance with [NFPA 70](#), using pressure grounding connectors especially designed for EMT.

3.2.5.3 Flexible Metallic Conduit

Use flexible metallic conduit to connect recessed fixtures from outlet boxes in ceilings, transformers, and other approved assemblies.

Use bonding wires in flexible conduit as specified in [NFPA 70](#), for all circuits. Flexible conduit is not considered a ground conductor.

Make electrical connections to vibration-isolated equipment with flexible metallic conduit.

Use liquidtight flexible metallic conduit in wet and oily locations and to complete the connection to motor-driven equipment.

Provide flexible steel conduit between [3 and 6 feet](#) in length for recessed and semirecessed lighting fixtures; for equipment subject to vibration, noise transmission, or movement; and for motors. Install flexible conduit to allow 20 percent slack. Minimum flexible steel conduit size: [1/2 inch](#) diameter. Provide liquidtight flexible conduit in wet and damp locations for equipment subject to vibration, noise transmission, movement or motors. Provide separate ground conductor across flexible connections.

3.2.5.4 Intermediate Conduit

Make all field-made bends and offsets with approved Hickey bending tool or conduit bending machine. Use intermediate metal conduit only for indoor installations.

3.2.5.5 Rigid Nonmetallic Conduit

Install a green insulated copper grounding conductor in conduit with conductors and solidly connect to ground at each end. Size grounding wires in accordance with [NFPA 70](#).

3.2.5.6 Underground Conduit

Plastic-coated rigid steel; plastic-coated steel IMC; PVC, Type EPC-40; or fiberglass. Convert nonmetallic conduit, other than PVC Schedule 40 or 80, to plastic-coated rigid, or IMC, steel conduit before rising through floor slab. Plastic coating: extend minimum [6 inches](#) above floor.

3.2.5.7 Stub Ups

Provide conduits stubbed up through concrete floor for connection to free-standing equipment with adjustable top or coupling threaded inside for plugs, set flush with finished floor. Extend conductors to equipment in rigid steel conduit, except that flexible metal conduit may be used [6 inches](#) above floor. Where no equipment connections are made, install screwdriver-operated threaded flush plugs in conduit end.

3.2.5.8 Conduit Support

Support conduit by pipe straps, wall brackets, threaded rod conduit hangers, or ceiling trapeze. Fasten by wood screws to wood; by toggle bolts on hollow masonry units; by concrete inserts or expansion bolts on concrete or brick; and by machine screws, welded threaded studs, or spring-tension clamps on steel work. Threaded C-clamps may be used on rigid steel conduit only. Do not weld conduits or pipe straps to steel structures. Do not exceed one-fourth proof test load for load applied to fasteners. Provide vibration resistant and shock-resistant fasteners attached to concrete ceiling. Do not cut main reinforcing bars for any holes cut to depth of more than **1 1/2 inches** in reinforced concrete beams or to depth of more than **3/4 inch** in concrete joints. Fill unused holes. In partitions of light steel construction, use sheet metal screws. In suspended-ceiling construction, run conduit above ceiling. Do not support conduit by ceiling support system. Conduit and box systems: supported independently of both (a) tie wires supporting ceiling grid system, and (b) ceiling grid system into which ceiling panels are placed. Do not share supporting means between electrical raceways and mechanical piping or ducts. Coordinate installation with above-ceiling mechanical systems to assure maximum accessibility to all systems. Spring-steel fasteners may be used for lighting branch circuit conduit supports in suspended ceilings in dry locations. Where conduit crosses building expansion joints, provide suitable expansion fitting that maintains conduit electrical continuity by bonding jumpers or other means. For conduits greater than **2 1/2 inches** inside diameter, provide supports to resist forces of 0.5 times the equipment weight in any direction and 1.5 times the equipment weight in the downward direction.

3.2.5.9 Directional Changes in Conduit Runs

Make changes in direction of runs with symmetrical bends or cast-metal fittings. Make field-made bends and offsets with hickey or conduit-bending machine. Do not install crushed or deformed conduits. Avoid trapped conduits. Prevent plaster, dirt, or trash from lodging in conduits, boxes, fittings, and equipment during construction. Free clogged conduits of obstructions.

3.2.5.10 Wireway and Auxiliary Gutter

Bolt together straight sections and fittings to provide a rigid, mechanical connection and electrical continuity. Close dead ends of wireways and auxiliary gutters. Plug all unused conduit openings.

Support wireways for overhead distribution and control circuits at maximum **5-foot** intervals.

Ensure auxiliary gutters used to supplement wiring spaces for equipment not contained in a single enclosure contains no switches, overcurrent devices, appliances, or apparatus and is not more than **30 feet** long.

3.2.6 Wiring

Color code feeder and branch circuit conductors as follows:

CONDUCTOR	COLOR AC
Phase A	Black (208VAC); Brown (480VAC)
Phase B	Red (208VAC); Orange (480VAC)
Phase C	Blue (208VAC); Yellow (480VAC)
Neutral	White
Equipment Grounds	Green

Use conductors up to and including [AWG No. 2](#) that are manufactured with colored insulating materials. For conductors larger than [AWG No. 2](#), have ends identified with color plastic tape in outlet, pull, or junction boxes.

Splice in accordance with the [NFPA 70](#). Provide conductor identification within each enclosure where a tap, splice, or termination is made and at the equipment terminal of each conductor. Match terminal and conductor identification as indicated.

Where several feeders pass through a common pullbox, tag the feeders to clearly indicate the electrical characteristics, circuit number, and panel designation.

3.2.7 Wiring Devices

3.2.7.1 Wall Switches and Receptacles

Install wall switches and receptacles so that when device plates are applied, the plates are aligned vertically to within [1/16 inch](#).

Bond ground terminal of each flush-mounted receptacle to the outlet box with an approved green bonding jumper when used with dry wall type construction.

3.2.7.2 Device Plates

Ensure device plates for switches are suitably engraved with a description of the loads when not within sight of the loads controlled.

Mark device plates and receptacle cover plates for receptacles other than 125-volt, single-phase, duplex, convenience outlets. Show the circuit number, voltage, frequency, phasing, and amperage available at the receptacle. Use self-adhesive labels having [1/4 inch](#) embossed letters.

Similarly mark device plates for convenience outlets indicating the supply panel and circuit number.

3.2.8 Splices and Connectors

Make all splices in [AWG No. 8](#) and smaller with approved insulated electrical type.

Make all splices in [AWG No. 6](#) and larger with indenter crimp-type connectors and compression tools. Wrap joints with an insulating tape that has an insulation and temperature rating equivalent to that of the

conductor.

3.2.9 Conductor Identification

Provide conductor identification within each enclosure where tap, splice, or termination is made. For conductors No. 6 AWG and smaller diameter, provide color coding by factory-applied, color-impregnated insulation. For conductors No. 4 AWG and larger diameter, provide color coding by plastic-coated, self-sticking markers; colored nylon cable ties and plates; or heat shrink-type sleeves. Identify control circuit terminations in accordance with.

3.2.9.1 Marking Strips

Provide marking strips in accordance with the following:

- a. Provide white or other light-colored plastic marking strips, fastened by screws to each terminal block, for wire designations.
- b. Use permanent ink for the wire numbers
- c. Provide reversible marking strips to permit marking both sides, or provide two marking strips with each block.
- d. Size marking strips to accommodate the two sets of wire numbers.
- e. Assign a device designation in accordance with **NEMA ICS 1** to each device to which a connection is made. Mark each device terminal to which a connection is made with a distinct terminal marking corresponding to the wire designation used on the Contractor's schematic and connection diagrams.
- f. The wire (terminal point) designations used on the Contractor's wiring diagrams and printed on terminal block marking strips may be according to the Contractor's standard practice; however, provide additional wire and cable designations for identification of remote (external) circuits for the Government's wire designations.
- g. Prints of the **marking strips** drawings submitted for approval will be so marked and returned to the Contractor for addition of the designations to the terminal strips and tracings, along with any rearrangement of points required.

3.2.10 Safety Switches

Securely fasten switches to the supporting structure or wall, utilizing a minimum of four **1/4 inch** bolts. Do not use sheet metal screws and small machine screws for mounting. Do not mount switches in an inaccessible location or where the passageway to the switch may become obstructed. Mounting height **5 feet** above floor level, when possible.

3.2.11 Boxes and Fittings

Provide pullboxes where necessary in the conduit system to facilitate conductor installation. For conduit runs longer than **100 feet** or with more than three right-angle bends, install a pullbox at a convenient intermediate location.

Securely mount boxes and enclosures to the building structure using

supports that are independent of the conduit entering or leaving the boxes.

Select the mounting height of wall-mounted outlet and switch boxes, as measured between the bottom of the box and the finished floor, in accordance with [ICC/ANSI A117.1](#) and as follows, unless otherwise indicated:

LOCATION	MOUNTING HEIGHT (inches)
Receptacles in offices	18
Receptacles in corridors	18
Receptacles in shops and laboratories	48
Receptacles in rest rooms	48
Switches for light control	48

3.2.12 Covers and Device Plates

Install with edges in continuous contact with finished wall surfaces without use of mats or similar devices. Plaster fillings are not permitted. Install plates with alignment tolerance of [1/16 inch](#). Use of sectional-type device plates are not permitted. Provide gasket for plates installed in wet locations.

3.2.13 Electrical Penetrations

Seal openings around electrical penetrations through fire resistance-rated walls, partitions, floors, or ceilings.

3.2.14 Panelboards

Securely mount panelboards so that the top operating handle does not exceed [72-inches](#) above the finished floor. Do not mount equipment within [36-inches](#) of the front of the panel. Ensure directory card information is complete and legible.

3.2.15 Surge Protective Devices

Connect the surge protective devices in parallel to the power source, keeping the conductors as short and straight as practically possible. Maximum allowed lead length is [3 feet](#).

3.2.16 Field Fabricated Nameplates

Ensure nameplates conform to [ASTM D709](#). Provide laminated plastic nameplates for each equipment enclosure, relay, switch, and device, as specified or as indicated on the drawings. Each nameplate inscription identifies the function and, when applicable, the position. Provide nameplates that are melamine plastic, [0.125-inch](#) thick, white with black center core and a matte finish surface with square corners. Accurately align lettering and engrave into the core. Minimum size of nameplates is [1 by 2.5 inches](#). Lettering is a minimum of [0.25-inch](#) high normal block style.

3.2.17 Identification Plates and Warnings

Provide identification plates for lighting and power panelboards, motor control centers, all line voltage heating and ventilating control panels, fire detector and sprinkler alarms, door bells, pilot lights, disconnect switches, manual starting switches, and magnetic starters. Attach identification plates to process control devices and pilot lights.

Install identification plates for all line voltage enclosed circuit breakers, identifying the equipment served, voltage, phase(s) and power source. For circuits 480 volts and above, install conspicuously located warning signs in accordance with OSHA requirements.

3.3 FIELD FABRICATED NAMEPLATE MOUNTING

Provide number, location, and letter designation of nameplates as indicated. Fasten nameplates to the device with a minimum of two sheet-metal screws or two rivets.

3.4 WARNING SIGN MOUNTING

Provide the number of signs required to be readable from each accessible side. Space the signs in accordance with NFPA 70E.

3.5 FIELD APPLIED MOUNTING

Paint electrical equipment as required to match finish of adjacent surfaces or to meet the indicated or specified safety criteria.

3.6 FIELD QUALITY CONTROL

After completion of the installation and splicing, and prior to energizing the conductors, perform wire and cable continuity and insulation tests as herein specified before the conductors are energized.

Provide all necessary test equipment, labor, and personnel to perform the tests, as herein specified.

Isolate completely all wire and cable from all extraneous electrical connections at cable terminations and joints. Use substation and switchboard feeder breakers, disconnects in combination motor starters, circuit breakers in panel boards, and other disconnecting devices to isolate the circuits under test.

Perform [insulation-resistance test](#) on each field-installed conductor with respect to ground and adjacent conductors. Applied potential is 500 volts dc for 300 volt rated cable and 1000 volts dc for 600 volt rated cable. Take readings after 1 minute and until the reading is constant for 15 seconds. Minimum insulation-resistance values is not less than 25 Megohms for 300 volt rated cable and 100 Megohms for 600 volt rated cable. For circuits with conductor sizes [AWG No. 8](#) and smaller insulation resistance testing is not required.

Perform [continuity test](#) to insure correct cable connection end-to-end (i.e correct phase conductor, grounded conductor, and grounding conductor wiring). Repair and verify any damages to existing or new electrical equipment resulting from mis-wiring. Receive approval for all repairs prior to commencement of the repair.

Conduct [phase-rotation tests](#) on all three-phase circuits using a

phase-rotation indicating instrument. Perform phase rotation of electrical connections to connected equipment in a clockwise direction, facing the source.

Perform **600-volt wiring test** on wiring rated 600 volt and less to verify that no short circuits or accidental grounds exist. Perform insulation resistance tests on wiring No. 6 AWG and larger diameter using instrument which applies voltage of approximately 500 volts to provide direct reading of resistance. Minimum resistance: 250,000 ohms.

Submit test reports in accordance with referenced standards in this section.

Final acceptance requires the successful performance of wire and cable under test. Do not energize any conductor until the final test reports are reviewed and approved.

-- End of Section --

SECTION 26 05 26.00 40

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS
08/19

PART 1 GENERAL

Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM applies to work specified in this section.

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN WELDING SOCIETY (AWS)

AWS A5.8/A5.8M (2019) Specification for Filler Metals for
Brazing and Braze Welding

ASTM INTERNATIONAL (ASTM)

ASTM B3 (2013) Standard Specification for Soft or
Annealed Copper Wire

ASTM B8 (2011; R 2017) Standard Specification for
Concentric-Lay-Stranded Copper Conductors,
Hard, Medium-Hard, or Soft

ASTM B187/B187M (2020) Standard Specification for Copper,
Bus Bar, Rod and Shapes and General
Purpose Rod, Bar and Shapes

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 81 (2012) Guide for Measuring Earth
Resistivity, Ground Impedance, and Earth
Surface Potentials of a Ground System

IEEE C2 (2017; Errata 1-2 2017; INT 1 2017)
National Electrical Safety Code

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI/NEMA GR 1 (2007) Grounding Rod Electrodes and
Grounding Rod Electrode Couplings

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (2020; ERTA 20-1 2020; ERTA 20-2 2020;
ERTA 20-3 2020; TIA 20-1; TIA 20-2; TIA
20-3; TIA 20-4; TIA 20-5; TIA 20-6; TIA
20-7; TIA 20-8; TIA 20-9; TIA 20-10; TIA
20-11; TIA 20-12; TIA 20-13; TIA 20-14;
TIA 20-15; TIA 20-16; ERTA 20-4 2022)
National Electrical Code

NFPA 780 (2023) Standard for the Installation of
Lightning Protection Systems

UNDERWRITERS LABORATORIES (UL)

UL 467 (2022) UL Standard for Safety Grounding
and Bonding Equipment

UL 546 (2008) UL Outline of Investigation for
Conductor Termination Compounds

1.2 SUBMITTALS

Government approval is required for submittals. Submit the following in accordance with the design build contractor's SATOC Task Order:

SD-03 Product Data

Ground Rods

Ground Wires

Connectors and Fasteners

Conductive Corrosion Inhibiting Compounds

Ground Buses

SD-06 Test Reports

Ground Resistance Tests

Equipment Continuity Test

SD-07 Certificates

Ground Resistance Test Equipment

SD-11 Closeout Submittals

Record Drawings

1.3 QUALITY CONTROL

1.3.1 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Ensure equipment, materials, installation, and workmanship are in accordance with the mandatory and advisory provisions of NFPA 70, IEEE C2 unless more stringent requirements are specified or indicated.

1.3.2 Standard Products

Provide materials and equipment that are products of manufacturers

regularly engaged in the production of such products which are of equal material, design and workmanship. Provide products which have been in satisfactory commercial or industrial use for 2 years prior to bid opening. Ensure the 2-year period includes applications of equipment and materials under similar circumstances and of similar size. Ensure the product has been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Where two or more items of the same class of equipment are required, these items must be products of a single manufacturer.

1.3.3 Ground Resistance Test Equipment

Provide combination 3-point and 4-point type ground resistance test equipment specifically designed for grounding electrode resistance and soil resistivity tests. Submit proof of current equipment calibration with test equipment product data.

PART 2 PRODUCTS

Submit material, equipment, and fixture lists for grounding systems, including manufacturer's style or catalog numbers, specification and drawing reference numbers, warranty information, and fabrication site information.

2.1 MATERIALS

2.1.1 Ground Rods

Provide ground rods of copper conforming to [UL 467](#) and [ANSI/NEMA GR 1](#). Ensure ground rods are not less than [3/4 inch](#) in diameter and [10 feet](#) in length.

Where ground rod length is greater than [10 feet](#), provide sectional type ground rods with each section [10 feet](#) in length. Join sectional type ground rods using threaded couplings that are welded at the threaded joints. Ensure ground rods have cone-shaped point on the end of the first section driven into the ground.

Provide ground rods and ground rod sections die-stamped near the top with the name or trademark of the manufacturer and the length of the segment in feet.

2.1.2 Ground Wires

2.1.2.1 Bare

Provide annealed bare copper, Class "B" stranded ground and bond wires in accordance with [ASTM B8](#) for wires #4 AWG and larger and solid in accordance with [ASTM B3](#) for wires #6 AWG and smaller. Provide conductors with 98 percent conductivity and sized wires in accordance with the requirements of [NFPA 70](#) and [NFPA 780](#).

2.1.2.2 Insulated

Ensure insulated conductors conform to the requirements of Section [26 05 00.00 40](#) COMMON WORK RESULTS FOR ELECTRICAL.

Where installed in conduit as part of a complete circuit provide conductors with green insulation for sizes #8 AWG and smaller and with

green phase tape at each end and in each junction box for sizes #6 AWG and larger.

2.1.2.3 Straps/Jumpers

Provide copper bonding straps and jumpers with a cross-sectional area of not less than **No. 6 AWG**. Ensure bonding straps and jumpers for shock-mounted devices with hinged joints are made of tinned-copper wire.

2.1.3 Connectors and Fasteners

2.1.3.1 Exothermic Welds

Ensure the molds, materials and powder charges used to make exothermic welds are the standard product of a single manufacturer and listed by the manufacturer for use on the specific type, size, quantity and configuration of conductors to which the weld is applied.

2.1.3.2 Irreversible Compression Lugs

Provide irreversible compression lug type connectors manufactured from tin-plated copper and installed using a hydraulic compression tool and die to apply correct, uniformly distributed, circumferential pressure. Ensure tools and dies are as recommended by the irreversible compression lug type connector manufacturer. Use an embossing die code or other standard method to provide visible indication that a connector has been adequately compressed onto the conductor. Apply irreversible compression lug type connectors in strict accordance with the manufacturer's written instructions and published installation instructions. Use 2-hole lug type connectors for connections to NEMA cable pads and bus bars, and single-hole connectors otherwise.

2.1.3.3 Fasteners

Provide bolts, nuts, washers, lock washers, and associated fasteners used for grounding and bonding connections manufactured of copper. Where fasteners contact dissimilar metals, apply conductive oxide-inhibiting compound.

2.1.4 Conductive Corrosion Inhibiting Compounds

Provide conductive corrosion inhibiting compounds UL Listed in accordance with **UL 546**, listed by the manufacturer as suitable for the application, and suitable for all aluminum and copper conductor/connector applications. Ensure conductive corrosion inhibiting compounds inhibit oxidation at the conductor/connector interface and have no deleterious effect on the conductor/connector metal or EPDM, natural rubber, or polyethylene insulating materials.

2.1.5 Ground Buses

Provide electro-tin plated, solid copper ground buses conforming to **ASTM B187/B187M** with minimum dimensions of **0.25 inches** thick, **4 inches** wide, and **12 inches** in length or as indicated. Ensure ground buses are equipped with two UL Recognized red 1000V rated insulated standoffs and stainless steel mounting brackets.

Provide grounding buses with predrilled NEMA hole configuration as indicated.

PART 3 EXECUTION

3.1 INSTALLATION

Install grounding systems in accordance with NFPA 70, NFPA 780 and IEEE C2, and as indicated.

Bond exposed non-current-carrying metallic parts of electrical equipment and metallic raceway systems to ground.

Bond grounding conductors in metallic and non-metallic raceways to ground. Make ground connections at equipment and to ground rods as indicated. Interconnect all grounding media in or on the structure to provide a common ground potential. This includes lightning protection, electrical service, telecommunications system grounds, as well as underground metallic piping systems.

Bond wiring system neutrals to ground in accordance with the requirements of NFPA 70. Where ground fault protection is employed, ensure that connection of ground and neutral does not interfere with correct operation of fault protection.

3.1.1 Ground Rods

Install ground rods so that the top of the rod is not less than 18 inches below finished grade.

3.1.2 Conductors

Install bare or insulated conductors as indicated. Install bare conductors where not specifically identified as bare or insulated except where installed in conduit with associated phase conductors. Install insulated conductors in conduit with insulation of the same material as the associated phase conductors with which it is installed.

Provide straps/jumpers across joints subject to vibration. Install strap/jumper such that vibration will not change its electrical characteristics. Apply strap/jumper to the metallic structure on each side of the joint; do not penetrate any adjacent parts. Install straps/jumpers in areas that are accessible for maintenance. Install strap/jumper such that it does not restrict the movement of the metallic structures to which it is connected. Install strap/jumper such that it does not weaken the metallic structures to which it is attached. Do not connect two or more straps/jumpers in series.

3.1.3 Ground Buses

Install ground busses in accordance with manufacturer's instructions.

3.1.4 Building Grounds

Install No. 4/ AWG bare copper ground conductor from existing main building grounding system to new ground bus.

3.1.5 Equipment Grounding

3.1.5.1 Equipment and Enclosure Bonding

Bond each metallic enclosure and all electrical equipment to ground. Make at least one copper connection from the system ground point to one or more enclosures in the area such that all enclosures and equipment provide a low-impedance path to ground when properly bonded together.

3.1.5.2 Bonding of Conduit and Raceway Systems

Bond all metal conduit, fittings, junction boxes, outlet boxes, armored and metal sheathed cable, and other raceways. Ensure adequate electrical contact at the joints and terminations. Ensure metallic raceway systems have electrical continuity with equipment. Individually and directly connect equipment to the building ground, independent of the raceway system.

For rigid metal conduit and terminations, ensure threaded connections are wrench-tight with no exposed threads. Ream all ends of the conduit to remove burrs and rough edges. Bond conduits entering boxes and enclosures to the box with bonding-type locknuts, one outside and one inside. Locknuts that gouge into the metal box when tightened are not acceptable.

Conduit systems that are interrupted by PVC dielectric links are bonded separately on either side of the link. Do not jumper the dielectric link.

Install flexible metal conduit with an integral grounding conductor.

3.1.6 Bonding Materials And Methods

Accomplish bonding of metal surfaces by brazing or clamping .

3.1.6.1 Brazing

Ensure brazing solder conforms to AWS A5.8/A5.8M.

3.1.6.2 Clamping

In external locations, use clamping only where a disconnect type of connection is required. Connection device may utilize spring-loaded jaws. Construct device such that positive contact pressure is maintained at all times. Use machine bolts with spring-type lockwashers.

3.1.6.3 Cleaning of Bonding Surfaces

Thoroughly clean surfaces that comprise the bond before joining. Apply an appropriate abrasive with gentle and uniform pressure to ensure a smooth and uniform surface. Do not remove excessive metal from the surface. Clean clad metals in such a manner that the cladding material is not penetrated by the cleaning process. Then clean bare metal with an appropriate solvent to remove any grease, oil, dirt, corrosion preventives, and other contaminants. Bond to the cleaned area within one hour after cleaning. Seal joint and refinish the exposed surfaces within two hours of exposure to prevent oxidation. When additional time is required, apply a corrosion preventive compound until the area can be refinished.

3.1.6.4 Protection of Finished Bonds

Protect finished bonds by painting to match the original finish after the bond is made.

3.2 FIELD QUALITY CONTROL

Perform the following tests in the presence of the Contracting Officer. Furnish test equipment and personnel and submit written results of each test. Notify the Contracting Officer at least 14 calendar working days prior to each test.

Submit written results of each test to Contracting Officer for review and approval. Document each location where test is performed, the field conditions at the time of the test, the measured results of the test, and whether the measured results "PASSED" or "FAILED" relative to specified pass/fail performance criteria.

Perform rework to correct FAILED conditions at no additional cost to the Government.

3.2.1 Ground Resistance Tests

Test grounding systems for ground resistance. Total resistance from any point on the ground network to the building counterpoise cannot exceed 50 milliohms.

Make ground resistance and counterpoise tests during dry weather, and no sooner than 48 hours after rainfall. Conduct tests using the ratio method that measures the ratio of the resistance to earth of an auxiliary test electrode to the series resistance of the electrode under test and a second auxiliary electrode. Perform measurements in accordance with IEEE 81.

3.2.2 Equipment Continuity Test

Test connection from electrical distribution equipment including panelboards, switchboards, transformers, substations, and motor control centers to counterpoise. Measure and record the circuit resistance between electrical equipment ground connections and the counterpoise. The circuit resistance shall not exceed 5 Ohms.

3.3 CLOSEOUT ACTIVITIES

Submit record drawings indicating the location of ground rods, mats, grids, building ground bus, supplementary grounding electrodes, steel building columns, and other metal structures connected to the grounding system.

-- End of Section --

SECTION 26 20 00

INTERIOR DISTRIBUTION SYSTEM

08/19, CHG 3: 11/21

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

- ASTM B1 (2013) Standard Specification for Hard-Drawn Copper Wire
- ASTM B8 (2011; R 2017) Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
- ASTM D709 (2017) Standard Specification for Laminated Thermosetting Materials

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

- IEEE 81 (2012) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System
- IEEE 100 (2000; Archived) The Authoritative Dictionary of IEEE Standards Terms

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

- NETA ATS (2021) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

NATIONAL ELECTRICAL CONTRACTORS ASSOCIATION (NECA)

- NECA NEIS 1 (2015) Standard for Good Workmanship in Electrical Construction

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

- ANSI C80.1 (2020) American National Standard for Electrical Rigid Steel Conduit (ERSC)
- ANSI C80.3 (2020) American National Standard for Electrical Metallic Tubing (EMT)
- ANSI C80.5 (2020) American National Standard for Electrical Rigid Aluminum Conduit
- NEMA 250 (2020) Enclosures for Electrical Equipment (1000 Volts Maximum)

NEMA FU 1	(2012) Low Voltage Cartridge Fuses
NEMA ICS 1	(2000; R 2015) Standard for Industrial Control and Systems: General Requirements
NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures
NEMA KS 1	(2013) Enclosed and Miscellaneous Distribution Equipment Switches (600 V Maximum)
NEMA TC 2	(2020) Standard for Electrical Polyvinyl Chloride (PVC) Conduit
NEMA TC 3	(2021) Polyvinyl Chloride (PVC) Fittings for Use With Rigid PVC Conduit and Tubing
NEMA WD 1	(1999; R 2020) Standard for General Color Requirements for Wiring Devices
NEMA WD 6	(2016) Wiring Devices Dimensions Specifications
NEMA Z535.4	(2011; R 2017) Product Safety Signs and Labels

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2020; ERTA 20-1 2020; ERTA 20-2 2020; ERTA 20-3 2020; TIA 20-1; TIA 20-2; TIA 20-3; TIA 20-4; TIA 20-5; TIA 20-6; TIA 20-7; TIA 20-8; TIA 20-9; TIA 20-10; TIA 20-11; TIA 20-12; TIA 20-13; TIA 20-14; TIA 20-15; TIA 20-16; ERTA 20-4 2022) National Electrical Code
NFPA 70E	(2021) Standard for Electrical Safety in the Workplace

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.147	The Control of Hazardous Energy (Lock Out/Tag Out)
29 CFR 1910.303	Electrical, General

UNDERWRITERS LABORATORIES (UL)

UL 1	(2005; Reprint Jan 2020) UL Standard for Safety Flexible Metal Conduit
UL 4	(2004; Reprint Mar 2021) UL Standard for Safety Armored Cable
UL 6	(2007; Reprint Sep 2019) UL Standard for Safety Electrical Rigid Metal Conduit-Steel

UL 6A	(2008; Reprint Mar 2021) UL Standard for Safety Electrical Rigid Metal Conduit - Aluminum, Red Brass, and Stainless Steel
UL 20	(2018; Reprint Jan 2021) UL Standard for Safety General-Use Snap Switches
UL 44	(2018; Reprint May 2021) UL Standard for Safety Thermoset-Insulated Wires and Cables
UL 50	(2015) UL Standard for Safety Enclosures for Electrical Equipment, Non-Environmental Considerations
UL 67	(2018; Reprint Jul 2020) UL Standard for Safety Panelboards
UL 83	(2017; Reprint Mar 2020) UL Standard for Safety Thermoplastic-Insulated Wires and Cables
UL 248-4	(2010; Reprint Apr 2019) Low-Voltage Fuses - Part 4: Class CC Fuses
UL 248-8	(2011; Reprint Aug 2020) Low-Voltage Fuses - Part 8: Class J Fuses
UL 248-10	(2011; Reprint Aug 2020) Low-Voltage Fuses - Part 10: Class L Fuses
UL 248-12	(2011; Reprint Aug 2020) Low Voltage Fuses - Part 12: Class R Fuses
UL 248-15	(2018) Low-Voltage Fuses - Part 15: Class T Fuses
UL 360	(2013; Reprint Aug 2021) UL Standard for Safety Liquid-Tight Flexible Metal Conduit
UL 467	(2022) UL Standard for Safety Grounding and Bonding Equipment
UL 486A-486B	(2018; Reprint May 2021) UL Standard for Safety Wire Connectors
UL 486C	(2018; Reprint May 2021) UL Standard for Safety Splicing Wire Connectors
UL 489	(2016; Rev 2019) UL Standard for Safety Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures
UL 510	(2020) UL Standard for Safety Polyvinyl Chloride, Polyethylene and Rubber Insulating Tape
UL 514A	(2013; Reprint Aug 2017) UL Standard for Safety Metallic Outlet Boxes

UL 514B	(2012; Reprint May 2020) Conduit, Tubing and Cable Fittings
UL 514C	(2014; Reprint Feb 2020) UL Standard for Safety Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers
UL 651	(2011; Reprint May 2022) UL Standard for Safety Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings
UL 797	(2007; Reprint Mar 2021) UL Standard for Safety Electrical Metallic Tubing -- Steel
UL 817	(2015; Reprint Sep 2021) UL Standard for Safety Cord Sets and Power-Supply Cords
UL 869A	(2006; Reprint Jun 2020) Reference Standard for Service Equipment
UL 870	(2016; Reprint Mar 2019) UL Standard for Safety Wireways, Auxiliary Gutters, and Associated Fittings
UL 943	(2016; Reprint Feb 2018) UL Standard for Safety Ground-Fault Circuit-Interruption
UL 1242	(2006; Reprint Apr 2022) UL Standard for Safety Electrical Intermediate Metal Conduit -- Steel
UL 1449	(2021) UL Standard for Safety Surge Protective Devices
UL 1660	(2019) Liquid-Tight Flexible Nonmetallic Conduit
UL 4248-1	(2022) UL Standard for Safety Fuseholders - Part 1: General Requirements
UL 4248-12	(2018) UL Standard for Safety Fuseholders - Part 12: Class R

1.2 DEFINITIONS

Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, are as defined in IEEE 100.

1.3 SUBMITTALS

Government approval is required for submittals. Submit the following in accordance with the design build contractor's SATOC Task Order:

SD-02 Shop Drawings

Panelboards

Wireways

Marking Strips Drawings

SD-03 Product Data

Receptacles

Circuit Breakers

Switches

Enclosed Circuit Breakers

Surge Protective Devices

SD-06 Test Reports

600-volt Wiring Test

Grounding System Test

SD-07 Certificates

Fuses

Electrical Systems, Data Package 5

1.4 QUALITY ASSURANCE

1.4.1 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "must" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Provide equipment, materials, installation, and workmanship in accordance with NFPA 70 unless more stringent requirements are specified or indicated. NECA NEIS 1 shall be considered the minimum standard for workmanship.

1.4.2 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship and:

- a. Have been in satisfactory commercial or industrial use for 2 years prior to bid opening including applications of equipment and materials under similar circumstances and of similar size.
- b. Have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period.
- c. Where two or more items of the same class of equipment are required, provide products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

1.4.2.1 Alternative Qualifications

Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

1.4.2.2 Material and Equipment Manufacturing Date

Products manufactured more than 3 years prior to date of delivery to site are not acceptable.

1.5 MAINTENANCE

1.5.1 Electrical Systems

Submit operation and maintenance data in accordance with Section 01 78 23, OPERATION AND MAINTENANCE DATA and as specified herein. Submit operation and maintenance manuals for electrical systems that provide basic data relating to the design, operation, and maintenance of the electrical distribution system for the building. Include the following:

- a. Single line diagram of the "as-built" building electrical system.
- b. Schematic diagram of electrical control system (other than HVAC, covered elsewhere).
- c. Manufacturers' operating and maintenance manuals on active electrical equipment.

1.6 WARRANTY

Provide equipment items supported by service organizations that are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

As a minimum, meet requirements of UL, where UL standards are established for those items, and requirements of NFPA 70 for all materials, equipment, and devices.

2.2 CONDUIT AND FITTINGS

Conform to the following:

2.2.1 Rigid Metallic Conduit

2.2.1.1 Rigid, Threaded Zinc-Coated Steel Conduit

ANSI C80.1, UL 6.

2.2.1.2 Rigid Aluminum Conduit

ANSI C80.5, UL 6A.

2.2.2 Rigid Nonmetallic Conduit

PVC Type EPC-40, and EPC-80 in accordance with NEMA TC 2, UL 651.

2.2.3 Intermediate Metal Conduit (IMC)

UL 1242, zinc-coated steel only.

2.2.4 Electrical, Zinc-Coated Steel Metallic Tubing (EMT)

UL 797, ANSI C80.3.

2.2.5 Flexible Metal Conduit

UL 1, limited to 6 feet.

2.2.5.1 Liquid-Tight Flexible Metal Conduit, Steel

UL 360, limited to 6 feet.

2.2.6 Fittings for Metal Conduit, EMT, and Flexible Metal Conduit

UL 514B. Ferrous fittings: cadmium- or zinc-coated in accordance with UL 514B.

2.2.6.1 Fittings for Rigid Metal Conduit and IMC

Threaded-type. Split couplings unacceptable.

2.2.6.2 Fittings for EMT

Steel compression type.

2.2.7 Fittings for Rigid Nonmetallic Conduit

NEMA TC 3 for PVC, and UL 514B.

2.2.8 Liquid-Tight Flexible Nonmetallic Conduit

UL 1660.

2.3 OUTLET BOXES AND COVERS

UL 514A, cadmium- or zinc-coated, if ferrous metal. UL 514C, if nonmetallic.

2.4 WIRES AND CABLES

Provide wires and cables in accordance applicable requirements of NFPA 70 and UL for type of insulation, jacket, and conductor specified or indicated. Do not use wires and cables manufactured more than 12 months prior to date of delivery to site.

2.4.1 Conductors

Provide the following:

- a. Conductor sizes and capacities shown are based on copper, unless indicated otherwise.

- b. Conductors No. 8 AWG and larger diameter: stranded.
- c. Conductors No. 10 AWG and smaller diameter: solid.
- d. Conductors for remote control, alarm, and signal circuits, classes 1, 2, and 3: stranded unless specifically indicated otherwise.
- e. All conductors: copper.

2.4.1.1 Minimum Conductor Sizes

Provide minimum conductor size in accordance with the following:

- a. Branch circuits: No. 12 AWG.
- b. Class 1 remote-control and signal circuits: No. 14 AWG.
- c. Class 2 low-energy, remote-control and signal circuits: No. 16 AWG.
- d. Class 3 low-energy, remote-control, alarm and signal circuits: No. 22 AWG.

2.4.2 Color Coding

Provide color coding for service, feeder, branch, control, and signaling circuit conductors.

2.4.2.1 Ground and Neutral Conductors

Provide color coding of ground and neutral conductors as follows:

- a. Grounding conductors: Green.
- b. Neutral conductors: White.
- c. Exception, where neutrals of more than one system are installed in same raceway or box, other neutrals color coding: white with a different colored (not green) stripe for each.

2.4.2.2 Ungrounded Conductors

Provide color coding of ungrounded conductors in different voltage systems as follows:

- a. 208/120 volt, three-phase
 - (1) Phase A - black
 - (2) Phase B - red
 - (3) Phase C - blue
- b. 480/277 volt, three-phase
 - (1) Phase A - brown
 - (2) Phase B - orange

(3) Phase C - yellow

- c. 120/240 volt, single phase: Black and red
- d. On three-phase, four-wire delta system, high leg: orange, as required by NFPA 70.

2.4.3 Insulation

Unless specified or indicated otherwise or required by NFPA 70, provide power and lighting wires rated for 600-volts, Type THWN/THHN conforming to UL 83 conforming to UL 44, except that grounding wire may be type TW conforming to UL 83; remote-control and signal circuits: Type TW or TF, conforming to UL 83. Where equipment or devices require 90-degree Centigrade (C) conductors, provide only conductors with 90-degree C insulation or better.

2.4.4 Bonding Conductors

ASTM B1, solid bare copper wire for sizes No. 8 AWG and smaller diameter; ASTM B8, Class B, stranded bare copper wire for sizes No. 6 AWG and larger diameter.

2.4.5 Armored Cable

UL 4; NFPA 70, Type AC cable.

2.4.6 Cord Sets and Power-Supply Cords

UL 817.

2.5 SPLICES AND TERMINATION COMPONENTS

UL 486A-486B for wire connectors and UL 510 for insulating tapes. Connectors for No. 10 AWG and smaller diameter wires: insulated, pressure-type in accordance with UL 486A-486B or UL 486C (twist-on splicing connector). Provide solderless terminal lugs on stranded conductors.

2.6 DEVICE PLATES

Provide the following:

- a. UL listed, one-piece device plates for outlets to suit the devices installed.
- b. For metal outlet boxes, plates on unfinished walls: zinc-coated sheet steel or cast metal having round or beveled edges.
- c. Plates on finished walls: satin finish stainless steel or brushed-finish aluminum, minimum 0.03 inch thick.
- d. Screws: machine-type with countersunk heads in color to match finish of plate.
- e. Sectional type device plates are not be permitted.
- f. Plates installed in wet locations: gasketed and UL listed for "wet locations."

2.7 SWITCHES

2.7.1 Toggle Switches

NEMA WD 1, UL 20, single pole, totally enclosed with bodies of thermoplastic or thermoset plastic and mounting strap with grounding screw. Include the following:

- a. Handles: gray thermoplastic.
- b. Wiring terminals: screw-type, side-wired.
- c. Contacts: silver-cadmium and contact arm - one-piece copper alloy.
- d. Switches: rated quiet-type ac only, 120/277 volts, with current rating and number of poles indicated.

2.7.2 Disconnect Switches

NEMA KS 1. Provide heavy duty-type switches where indicated, where switches are rated higher than 240 volts, and for double-throw switches. Utilize Class R fuseholders and fuses for fused switches, unless indicated otherwise. Provide horsepower rated for switches serving as the motor-disconnect means. Provide switches in NEMA 1, 3R, enclosure as indicated per NEMA ICS 6.

2.8 FUSES

NEMA FU 1. Provide complete set of fuses for each fusible switch. Coordinate time-current characteristics curves of fuses serving motors or connected in series with circuit breakers for proper operation. Submit coordination data for approval. Provide fuses with a voltage rating not less than circuit voltage.

2.8.1 Fuseholders

Provide in accordance with UL 4248-1.

2.8.2 Cartridge Fuses, Current Limiting Type (Class R)

UL 248-12, Class RK-5 time-delay type. Provide only Class R associated fuseholders in accordance with UL 4248-12.

2.8.3 Cartridge Fuses, High-Interrupting Capacity, Current Limiting Type (Classes J, L, and CC)

UL 248-8, UL 248-10, UL 248-4, Class J for zero to 600 amperes, Class L for 601 to 6,000 amperes, and Class CC for zero to 30 amperes.

2.8.4 Cartridge Fuses, Current Limiting Type (Class T)

UL 248-15, Class T for zero to 1,200 amperes, 300 volts; and zero to 800 amperes, 600 volts.

2.9 RECEPTACLES

Provide the following:

- a. Ratings and configurations: as indicated.
- b. Bodies: gray as per NEMA WD 1.
- c. Face and body: thermoplastic supported on a metal mounting strap.
- d. Dimensional requirements: per NEMA WD 6.
- e. Screw-type, side-wired wiring terminals or of the solderless pressure type having suitable conductor-release arrangement.
- f. Grounding pole connected to mounting strap.
- g. The receptacle: containing triple-wipe power contacts and double or triple-wipe ground contacts.

2.9.1 Weatherproof Receptacles

Provide receptacles, UL listed for use in "wet locations" with integral GFCI protection. Include cast metal box with gasketed, hinged, lockable and weatherproof while-in-use, die-cast metal/aluminum cover plate.

2.9.2 Ground-Fault Circuit Interrupter Receptacles

UL 943, duplex type for mounting in standard outlet box. Provide device capable of detecting current leak when the current to ground is 6 milliamperes or higher, and tripping per requirements of UL 943 for Class A ground-fault circuit interrupter devices. Provide screw-type, side-wired wiring terminals or pre-wired (pigtail) leads.

2.10 PANELBOARDS

Provide panelboards in accordance with the following:

- a. UL 67 and UL 50 having a short-circuit current rating as indicated.
- b. Panelboards: circuit breaker-equipped.
- c. Designed such that individual breakers can be removed without disturbing adjacent units or without loosening or removing supplemental insulation supplied as means of obtaining clearances as required by UL.
- d. "Specific breaker placement" is required in panelboards to match the breaker placement indicated in the panelboard schedule on the design drawings. If it is not possible to match "specific breaker placement" during construction, obtain Government approval prior to device installation.
- e. Use of "Subfeed Breakers" is not acceptable.
- f. Main breaker: "separately" mounted "above" or "below" branch breakers.
- g. Where "space only" is indicated, make provisions for future installation of breakers.
- h. Directories: indicate load served by each circuit in panelboard.
- ij. Directories: indicate source of service to panelboard (e.g., Panel

PA served from Panel MDP).

- j. Provide new directories for existing panels modified by this project as indicated.
- k. Type directories and mount in holder behind transparent protective covering.
- l. Panelboards: listed and labeled for their intended use.
- m. Panelboard nameplates: provided in accordance with paragraph FIELD FABRICATED NAMEPLATES.
- n. UL 67 and UL 50.
- o. Panelboards for use as service disconnecting: additionally conform to UL 869A.
- p. Panelboards: circuit breaker-equipped.
- q. Designed such that individual breakers can be removed without disturbing adjacent units or without loosening or removing supplemental insulation supplied as means of obtaining clearances as required by UL.
- r. Where "space only" is indicated, make provisions for future installation of breaker sized as indicated.
- s. Directories: indicate load served by each circuit of panelboard.
- t. Directories: indicate source of service (e.g. upstream panel, switchboard, motor control center) to panelboard.
- u. Type directories and mount in holder behind transparent protective covering.
- v. Panelboard nameplates: provided in accordance with paragraph FIELD FABRICATED NAMEPLATES.

2.10.1 Enclosure

Provide panelboard enclosure in accordance with the following:

- a. UL 50.
- b. Cabinets mounted outdoors or flush-mounted: hot-dipped galvanized after fabrication.
- c. Cabinets: painted in accordance with paragraph PAINTING.
- d. Outdoor cabinets: NEMA 3R raintight with conduit hubs welded to the cabinet.
- e. Front edges of cabinets: form-flanged or fitted with structural shapes welded or riveted to the sheet steel, for supporting the panelboard front.
- f. All cabinets: fabricated such that no part of any surface on the finished cabinet deviates from a true plane by more than 1/8 inch.

- g. Holes: provided in the back of indoor surface-mounted cabinets, with outside spacers and inside stiffeners, for mounting the cabinets with a $\frac{1}{2}$ inch clear space between the back of the cabinet and the wall surface.
- h. Flush doors: mounted on hinges that expose only the hinge roll to view when the door is closed.
- i. Each door: fitted with a combined catch and lock latch.
- j. Keys: two provided with each lock, with all locks keyed alike.
- k. Finished-head cap screws: provided for mounting the panelboard fronts on the cabinets.

2.10.2 Panelboard Buses

Support bus bars on bases independent of circuit breakers. Design main buses and back pans so that breakers may be changed without machining, drilling, or tapping. Provide isolated neutral bus in each panel for connection of circuit neutral conductors. Provide separate ground bus identified as equipment grounding bus per [UL 67](#) for connecting grounding conductors; bond to steel cabinet.

2.10.2.1 Panelboard Neutrals for Non-Linear Loads

Provide in accordance with the following:.

- a. UL listed, with panelboard type specifically UL heat rise tested for use on non-linear loads.
- b. Panelboard: heat rise tested in accordance with [UL 67](#), except with the neutral assembly installed and carrying 200 percent of the phase bus current during testing.
- c. Verification of the testing procedure: provided upon request.
- d. Two neutral assemblies paralleled together with cable is not acceptable.
- e. Nameplates for panelboard rated for use on non-linear loads: marked "SUITABLE FOR NON-LINEAR LOADS" and in accordance with paragraph FIELD FABRICATED NAMEPLATES.
- f. Provide a neutral label with instructions for wiring the neutral of panelboards rated for use on non-linear loads.

2.10.3 [Circuit Breakers](#)

[UL 489](#), thermal magnetic-type having a minimum short-circuit current rating equal to the short-circuit current rating of the panelboard in which the circuit breaker will be mounted. Breaker terminals: UL listed as suitable for type of conductor provided. Where indicated on the drawings, provide circuit breakers with shunt trip devices. Series rated circuit breakers and plug-in circuit breakers are unacceptable.

2.10.3.1 Multipole Breakers

Provide common trip-type with single operating handle. Design breaker

such that overload in one pole automatically causes all poles to open. Maintain phase sequence throughout each panel so that any three adjacent breaker poles are connected to Phases A, B, and C, respectively.

2.10.3.2 Circuit Breaker With Ground-Fault Circuit Interrupter

UL 943 and NFPA 70. Provide with auto-monitoring (self-test) and lockout features, "push-to-test" button, visible indication of tripped condition, and ability to detect and trip when current imbalance is 6 milliamperes or higher per requirements of UL 943 for Class A ground-fault circuit interrupter devices.

2.11 ENCLOSED CIRCUIT BREAKERS

UL 489. Individual molded case circuit breakers with voltage and continuous current ratings, number of poles, overload trip setting, and short circuit current interrupting rating as indicated. Enclosure type as indicated. Provide solid neutral.

2.12 LOCKOUT REQUIREMENTS

Provide circuit breakers, disconnecting means, and other devices that are electrical energy-isolating capable of being locked out for machines and other equipment to prevent unexpected startup or release of stored energy in accordance with 29 CFR 1910.147, NFPA 70E and 29 CFR 1910.303. Comply with requirements of Division 23, "Mechanical" for mechanical isolation of machines and other equipment.

2.13 GROUNDING AND BONDING EQUIPMENT

2.13.1 Ground Rods

UL 467. Ground rods: cone pointed solid copper, with minimum diameter of 3/4 inch and minimum length 10 feet. Sectional type rods may be used for rods 20 feet or longer.

2.13.2 Ground Bus

Copper ground bus: provided in the electrical equipment rooms as indicated.

2.14 MANUFACTURER'S NAMEPLATE

Provide on each item of equipment a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

2.15 FIELD FABRICATED NAMEPLATES

Provide field fabricated nameplates in accordance with the following:

- a. ASTM D709.
- b. Provide laminated plastic nameplates for each equipment enclosure, relay, switch, and device; as specified or as indicated on the drawings.
- c. Each nameplate inscription: identify the function and, when

applicable, the position.

- d. Nameplates: melamine plastic, 0.125 inch thick, white with black center core.
- e. Provide red laminated plastic label with white center core for emergency power equipment.
- f. Surface: matte finish. Corners: square. Accurately align lettering and engrave into the core.
- g. Minimum size of nameplates: one by 2.5 inches.
- h. Lettering size and style: a minimum of 0.25 inch high normal block style.

2.16 WARNING SIGNS

Provide warning signs for flash protection in accordance with NFPA 70E and NEMA Z535.4 for switchboards, panelboards, industrial control panels, and motor control centers that are in other than dwelling occupancies and are likely to require examination, adjustment, servicing, or maintenance while energized. Provide field installed signs to warn qualified persons of potential electric arc flash hazards when warning signs are not provided by the manufacturer. Provide marking that is clearly visible to qualified persons before examination, adjustment, servicing, or maintenance of the equipment.

2.17 WIREWAYS

UL 870. Material: steel galvanized 16 gauge for heights and depths up to 6 by 6 inches, and 14 gauge for heights and depths up to 12 by 12 inches. Provide in length required for the application with hinged- cover NEMA 1 enclosure per NEMA ICS 6.

2.18 SURGE PROTECTIVE DEVICES

Provide parallel type surge protective devices (SPD) which comply with UL 1449 at the service entrance panelboards and switchboards. Provide surge protectors in a NEMA 1 enclosure per NEMA ICS 6. SPD must have the same short-circuit current rating as the protected equipment and must not be installed at a point of system where the available fault current is in excess of that rating. Use Type 1 or Type 2 SPD and connect on the load side of a dedicated circuit breaker. Submit performance and characteristic curves.

Provide the following modes of protection:

FOR SINGLE PHASE AND THREE PHASE WYE CONNECTED SYSTEMS-

- Phase to phase (L-L)
- Each phase to neutral (L-N)
- Neutral to ground (N-G)
- Phase to ground (L-G)

SPDs at the service entrance: provide with a minimum surge current rating of 120,000 amperes for L-L mode minimum and 40,000 amperes for other modes (L-N, L-G, and N-G).

Provide SPDs. Maximum L-N, L-G, and N-G Voltage Protection Rating:

700V for 120/240V, single phase system
700V for 208Y/120V, three phase system
1,200V for 480Y/277V, three phase system

Maximum L-L Voltage Protection Rating:

1,200V for 120V, single phase system
1,200V for 120/240V, single phase system
1,200V for 208Y/120V, three phase system
2,000V for 480Y/277V, three phase system

The minimum MCOV (Maximum Continuous Operating Voltage) rating for L-N and L-G modes of operation: 120 percent of nominal voltage for 240 volts and below; 115 percent of nominal voltage above 240 volts to 480 volts.

2.19 FACTORY APPLIED FINISH

Provide factory-applied finish on electrical equipment in accordance with the following:

- a. **NEMA 250** corrosion-resistance test and the additional requirements as specified herein.
- b. Interior and exterior steel surfaces of equipment enclosures: thoroughly cleaned followed by a rust-inhibitive phosphatizing or equivalent treatment prior to painting.
- c. Exterior surfaces: free from holes, seams, dents, weld marks, loose scale or other imperfections.
- d. Interior surfaces: receive not less than one coat of corrosion-resisting paint in accordance with the manufacturer's standard practice.
- e. Exterior surfaces: primed, filled where necessary, and given not less than two coats baked enamel with semigloss finish.
- f. Equipment located indoors: ANSI Light Gray, and equipment located outdoors: ANSI Light Gray.
- g. Provide manufacturer's coatings for touch-up work and as specified in paragraph FIELD APPLIED PAINTING.

2.20 SOURCE QUALITY CONTROL

2.21 COORDINATED POWER SYSTEM PROTECTION

Prepare analyses as specified in Section **26 28 01.00 10** COORDINATED POWER SYSTEM PROTECTION.

PART 3 EXECUTION

3.1 INSTALLATION

Electrical installations, including weatherproof and hazardous locations and ducts, plenums and other air-handling spaces: conform to requirements of **NFPA 70** and to requirements specified herein.

3.1.1 Underground Service

Underground service conductors and associated conduit: continuous from service entrance equipment to outdoor power system connection.

3.1.2 Service Entrance Identification

Service entrance disconnect devices, switches, and enclosures: labeled and identified as such.

3.1.2.1 Labels

Wherever work results in service entrance disconnect devices in more than one enclosure, as permitted by NFPA 70, label each enclosure, new and existing, as one of several enclosures containing service entrance disconnect devices. Label, at minimum: indicate number of service disconnect devices housed by enclosure and indicate total number of enclosures that contain service disconnect devices. Provide laminated plastic labels conforming to paragraph FIELD FABRICATED NAMEPLATES. Use lettering of at least 0.25 inch in height, and engrave on black-on-white matte finish. Service entrance disconnect devices in more than one enclosure: provided only as permitted by NFPA 70.

3.1.3 Wiring Methods

Provide insulated conductors installed in rigid steel conduit, IMC, rigid nonmetallic conduit, or EMT, except where specifically indicated or specified otherwise or required by NFPA 70 to be installed otherwise. Grounding conductor: separate from electrical system neutral conductor. Provide insulated green equipment grounding conductor for circuit(s) installed in conduit and raceways. Shared neutral, or multi-wire branch circuits, are not permitted with arc-fault circuit interrupters. Minimum conduit size: 1/2 inch in diameter for low voltage lighting and power circuits. Vertical distribution in multiple story buildings: made with metal conduit in fire-rated shafts, with metal conduit extending through shafts for minimum distance of 6 inches.

3.1.3.1 Pull Wire

Install pull wires in empty conduits. Pull wire: plastic having minimum 200-pound force tensile strength. Leave minimum 36 inches of slack at each end of pull wire.

3.1.4 Conduit Installation

Unless indicated otherwise, conceal conduit under floor slabs and within finished walls, ceilings, and floors. Keep conduit minimum 6 inches away from parallel runs of flues and steam or hot water pipes. Install conduit parallel with or at right angles to ceilings, walls, and structural members where located above accessible ceilings and where conduit will be visible after completion of project.

3.1.4.1 Restrictions Applicable to Aluminum Conduit

- a. Do not install underground or encase in concrete or masonry.
- b. Do not use brass or bronze fittings.
- c. Do not use when the enclosed conductors must be shielded from the

effects of High-altitude Electromagnetic Pulse (HEMP).

3.1.4.2 Restrictions Applicable to EMT

- a. Do not install underground.
- b. Do not encase in concrete, mortar, grout, or other cementitious materials.
- c. Do not use in areas subject to physical damage including but not limited to equipment rooms where moving or replacing equipment could physically damage the EMT.
- d. Do not use outdoors.
- e. Do not use when the enclosed conductors must be shielded from the effects of High-altitude Electromagnetic Pulse (HEMP).

3.1.4.3 Restrictions Applicable to Nonmetallic Conduit

- a. PVC Schedule 40.
 - (1) Do not use where subject to physical damage, including but not limited to, mechanical equipment rooms, electrical equipment rooms, fire pump rooms, and where restrictions are applying to both PVC Schedule 40 and PVC Schedule 80.
 - (2) Do not use above grade, except where allowed in this section for rising through floor slab or indicated otherwise.
- b. PVC Schedule 40 and Schedule 80.
 - (1) Do not use where subject to physical damage, including but not limited to, hospitals, power plant, missile magazines, and other such areas.
 - (2) Do not use in hazardous (classified) areas.
 - (3) Do not use in penetrating fire-rated walls or partitions, or fire-rated floors.

-

3.1.4.4 Restrictions Applicable to Flexible Conduit

Use only as specified in paragraph FLEXIBLE CONNECTIONS. Do not use when the enclosed conductors must be shielded from the effects of High-altitude Electromagnetic Pulse (HEMP).

3.1.4.5 Underground Conduit

Plastic-coated rigid steel; plastic-coated steel IMC; PVC, Type EPC-40. Convert nonmetallic conduit, other than PVC Schedule 40 or 80, to plastic-coated rigid, or IMC, steel conduit before rising through floor slab. Plastic coating: extend minimum 6 inches above floor.

3.1.4.6 Conduit Installed in Concrete Floor Slabs

PVC, Type EPC-40, unless indicated otherwise. Locate so as not to adversely affect structural strength of slabs. Install conduit within middle one-third of concrete slab. Do not stack conduits. Space conduits

horizontally not closer than three diameters, except at cabinet locations. Curved portions of bends must not be visible above finish slab. Increase slab thickness as necessary to provide minimum **one inch** cover over conduit. Where embedded conduits cross building expansion joints, provide suitable watertight expansion/deflection fittings and bonding jumpers. Expansion/deflection fittings must allow horizontal and vertical movement of raceway. Conduit larger than **one inch** trade size: installed parallel with or at right angles to main reinforcement; when at right angles to reinforcement, install conduit close to one of supports of slab. Where nonmetallic conduit is used, convert raceway to plastic coated rigid steel or plastic coated steel IMC before rising above floor, unless specifically indicated.

3.1.4.7 Stub-Ups

Provide conduits stubbed up through concrete floor for connection to free-standing equipment with adjustable top or coupling threaded inside for plugs, set flush with finished floor. Extend conductors to equipment in rigid steel conduit, except that flexible metal conduit may be used **6 inches** above floor. Where no equipment connections are made, install screwdriver-operated threaded flush plugs in conduit end.

3.1.4.8 Conduit Support

Support conduit by pipe straps, wall brackets, threaded rod conduit hangers, or ceiling trapeze. Plastic cable ties are not acceptable. Fasten by wood screws to wood; by toggle bolts on hollow masonry units; by concrete inserts or expansion bolts on concrete or brick; and by machine screws, welded threaded studs, or spring-tension clamps on steel work. Threaded C-clamps may be used on rigid steel conduit only. Do not weld conduits or pipe straps to steel structures. Do not exceed one-fourth proof test load for load applied to fasteners. Provide vibration resistant and shock-resistant fasteners attached to concrete ceiling. Do not cut main reinforcing bars for any holes cut to depth of more than **1 1/2 inches** in reinforced concrete beams or to depth of more than **3/4 inch** in concrete joints. Fill unused holes. In partitions of light steel construction, use sheet metal screws. In suspended-ceiling construction, run conduit above ceiling. Do not support conduit by ceiling support system. Conduit and box systems: supported independently of both (a) tie wires supporting ceiling grid system, and (b) ceiling grid system into which ceiling panels are placed. Do not share supporting means between electrical raceways and mechanical piping or ducts. Coordinate installation with above-ceiling mechanical systems to assure maximum accessibility to all systems. Spring-steel fasteners may be used for lighting branch circuit conduit supports in suspended ceilings in dry locations. Where conduit crosses building expansion joints, provide suitable expansion fitting that maintains conduit electrical continuity by bonding jumpers or other means. For conduits greater than **2 1/2 inches** inside diameter, provide supports to resist forces of 0.5 times the equipment weight in any direction and 1.5 times the equipment weight in the downward direction.

3.1.4.9 Directional Changes in Conduit Runs

Make changes in direction of runs with symmetrical bends or cast-metal fittings. Make field-made bends and offsets with hickey or conduit-bending machine. Do not install crushed or deformed conduits. Avoid trapped conduits. Prevent plaster, dirt, or trash from lodging in conduits, boxes, fittings, and equipment during construction. Free

clogged conduits of obstructions.

3.1.4.10 Locknuts and Bushings

Fasten conduits to sheet metal boxes and cabinets with two locknuts where required by **NFPA 70**, where insulated bushings are used, and where bushings cannot be brought into firm contact with the box; otherwise, use at least minimum single locknut and bushing. Provide locknuts with sharp edges for digging into wall of metal enclosures. Install bushings on ends of conduits, and provide insulating type where required by **NFPA 70**.

3.1.4.11 Flexible Connections

Provide flexible steel conduit between **3 and 6 feet** in length for recessed and semirecessed lighting fixtures; for equipment subject to vibration, noise transmission, or movement; and for motors. Install flexible conduit to allow 20 percent slack. Minimum flexible steel conduit size: **1/2 inch** diameter. Provide liquid tight flexible conduit in wet and damp locations for equipment subject to vibration, noise transmission, movement or motors. Provide separate ground conductor across flexible connections. Plastic cable ties are not acceptable as a support method.

3.1.5 Boxes, Outlets, and Supports

Provide boxes in wiring and raceway systems wherever required for pulling of wires, making connections, and mounting of devices or fixtures. Boxes for metallic raceways: cast-metal, hub-type when located in wet locations, when surface mounted on outside of exterior surfaces, when surface mounted on interior walls exposed up to **7 feet** above floors and walkways, and when specifically indicated. Boxes in other locations: sheet steel, except that aluminum boxes may be used with aluminum conduit, and nonmetallic boxes may be used with nonmetallic conduit system. Provide each box with volume required by **NFPA 70** for number of conductors enclosed in box. Boxes for mounting lighting fixtures: minimum **4 inches** square, or octagonal, except that smaller boxes may be installed as required by fixture configurations, as approved. Boxes for use in masonry-block or tile walls: square-cornered, tile-type, or standard boxes having square-cornered, tile-type covers. Provide gaskets for cast-metal boxes installed in wet locations and boxes installed flush with outside of exterior surfaces. Provide separate boxes for flush or recessed fixtures when required by fixture terminal operating temperature; provide readily removable fixtures for access to boxes unless ceiling access panels are provided. Support boxes and pendants for surface-mounted fixtures on suspended ceilings independently of ceiling supports. Fasten boxes and supports with wood screws on wood, with bolts and expansion shields on concrete or brick, with toggle bolts on hollow masonry units, and with machine screws or welded studs on steel. Threaded studs driven in by powder charge and provided with lock washers and nuts or nail-type nylon anchor may be used in lieu of wood screws, expansion shields, or machine screws. In open overhead spaces, cast boxes threaded to raceways need not be separately supported except where used for fixture support; support sheet metal boxes directly from building structure or by bar hangers. Where bar hangers are used, attach bar to raceways on opposite sides of box, and support raceway with approved-type fastener maximum **24 inches** from box. When penetrating reinforced concrete members, avoid cutting reinforcing steel.

3.1.5.1 Boxes

Boxes for use with raceway systems: minimum 1 1/2 inches deep, except where shallower boxes required by structural conditions are approved. Boxes for other than lighting fixture outlets: minimum 4 inches square, except that 4 by 2 inch boxes may be used where only one raceway enters outlet. Mount outlet boxes flush in finished walls.

3.1.5.2 Pull Boxes

Construct of at least minimum size required by NFPA 70 of code-gauge aluminum or galvanized sheet steel, except where cast-metal boxes are required in locations specified herein. Provide boxes with screw-fastened covers. Where several feeders pass through common pull box, tag feeders to indicate clearly electrical characteristics, circuit number, and panel designation.

3.1.6 Mounting Heights

Mount panelboards, enclosed circuit breakers, and disconnecting switches so height of center of grip of the operating handle of the switch or circuit breaker at its highest position is maximum 79 inches above floor or working platform or as allowed in Section 404.8 per NFPA 70. Mount lighting switches 48 inches above finished floor. Mount receptacles 18 inches above finished floor, unless otherwise indicated. Mount other devices as indicated. Measure mounting heights of wiring devices and outlets to center of device or outlet. Measure mounting heights of receptacle outlet boxes to the bottom of the outlet box.

3.1.7 Conductor Identification

Provide conductor identification within each enclosure where tap, splice, or termination is made. For conductors No. 6 AWG and smaller diameter, provide color coding by factory-applied, color-impregnated insulation. For conductors No. 4 AWG and larger diameter, provide color coding by plastic-coated, self-sticking markers; colored nylon cable ties and plates; or heat shrink-type sleeves.

3.1.7.1 Marking Strips

Provide marking strips for identification of power distribution, control, data, and communications cables in accordance with the following:

- a. Provide white or other light-colored plastic marking strips, fastened by screws to each terminal block, for wire designations.
- b. Use permanent ink for the wire numbers
- c. Provide reversible marking strips to permit marking both sides, or provide two marking strips with each block.
- d. Size marking strips to accommodate the two sets of wire numbers.
- e. Assign a device designation in accordance with NEMA ICS 1 to each device to which a connection is made. Mark each device terminal to which a connection is made with a distinct terminal marking corresponding to the wire designation used on the Contractor's schematic and connection diagrams.

- f. The wire (terminal point) designations used on the Contractor's wiring diagrams and printed on terminal block marking strips may be according to the Contractor's standard practice; however, provide additional wire and cable designations for identification of remote (external) circuits for the Government's wire designations.
- g. Prints of the [marking strips](#) drawings submitted for approval will be so marked and returned to the Contractor for addition of the designations to the terminal strips and tracings, along with any rearrangement of points required.

3.1.8 Splices

Make splices in accessible locations. Make splices in conductors No. 10 AWG and smaller diameter with insulated, pressure-type connector. Make splices in conductors No. 8 AWG and larger diameter with solderless connector, and cover with insulation material equivalent to conductor insulation.

3.1.9 Covers and Device Plates

Install with edges in continuous contact with finished wall surfaces without use of mats or similar devices. Plaster fillings are not permitted. Install plates with alignment tolerance of [1/16 inch](#). Use of sectional-type device plates are not permitted. Provide gasket for plates installed in wet locations.

3.1.10 Grounding and Bonding

Provide in accordance with [NFPA 70](#). Ground exposed, non-current-carrying metallic parts of electrical equipment, metallic raceway systems, grounding conductor in metallic and nonmetallic raceways, and neutral conductor of wiring systems. Make ground connection at main service equipment, and extend grounding conductor to point of entrance of metallic water service. Make connection to water pipe by suitable ground clamp or lug connection to plugged tee. If flanged pipes are encountered, make connection with lug bolted to street side of flanged connection. Supplement metallic water service grounding system with additional made electrode in compliance with [NFPA 70](#). Make ground connection to driven ground rods on exterior of building. Bond additional driven rods together with a minimum of 4 AWG soft bare copper wire buried to a depth of at least [12 inches](#). Interconnect all grounding media in or on the structure to provide a common ground potential. Make interconnection to the gas line on the customer's side of the meter. Where ground fault protection is employed, ensure that connection of ground and neutral does not interfere with correct operation of fault protection.

3.1.10.1 Ground Rods

Provide ground rods and measure the resistance to ground using the fall-of-potential method described in [IEEE 81](#). Do not exceed 25 ohms under normally dry conditions for the maximum resistance of a driven ground. If this resistance cannot be obtained with a single rod, [4](#) additional rods, spaced on center. Spacing for additional rods must be a minimum of [10 feet](#), or if sectional type rods are used, [1](#) additional sections may be coupled and driven with the first rod. If the resultant resistance exceeds 25 ohms measured not less than 48 hours after rainfall, notify the Contracting Officer who will decide on the number of ground rods to add.

3.1.10.2 Grounding Connections

Make grounding connections which are buried or otherwise normally inaccessible, excepting specifically those connections for which access for periodic testing is required, by exothermic weld or high compression connector.

- a. Make exothermic welds strictly in accordance with the weld manufacturer's written recommendations. Welds which are "puffed up" or which show convex surfaces indicating improper cleaning are not acceptable. Mechanical connectors are not required at exothermic welds.
- b. Make high compression connections using a hydraulic or electric compression tool to provide the correct circumferential pressure. Provide tools and dies as recommended by the manufacturer. Use an embossing die code or other standard method to provide visible indication that a connector has been adequately compressed on the ground wire.

3.1.10.3 Ground Bus

Provide a copper ground bus in the electrical equipment rooms as indicated. Noncurrent-carrying metal parts of transformer neutrals and other electrical equipment: effectively grounded by bonding to the ground bus. Bond the ground bus to both the entrance ground, and to a ground rod or rods as specified above having the upper ends terminating approximately 4 inches above the floor. Make connections and splices of the brazed, welded, bolted, or pressure-connector type, except use pressure connectors or bolted connections for connections to removable equipment.

3.1.10.4 Resistance

Maximum resistance-to-ground of grounding system: do not exceed 25 ohms under dry conditions. Where resistance obtained exceeds 25 ohms, contact Contracting Officer for further instructions.

3.1.11 Equipment Connections

Provide power wiring for the connection of motors and control equipment under this section of the specification. Except as otherwise specifically noted or specified, automatic control wiring, control devices, and protective devices within the control circuitry are not included in this section of the specifications and are provided under the section specifying the associated equipment.

3.1.12 Repair of Existing Work

Perform repair of existing work, demolition, and modification of existing electrical distribution systems as follows:

3.1.12.1 Workmanship

Lay out work in advance. Exercise care where cutting, channeling, chasing, or drilling of floors, walls, partitions, ceilings, or other surfaces is necessary for proper installation, support, or anchorage of conduit, raceways, or other electrical work. Repair damage to buildings, piping, and equipment using skilled craftsmen of trades involved.

3.1.12.2 Existing Concealed Wiring to be Removed

Disconnect existing concealed wiring to be removed from its source. Remove conductors; cut conduit flush with floor, underside of floor, and through walls; and seal openings.

3.1.12.3 Removal of Existing Electrical Distribution System

Removal of existing electrical distribution system equipment includes equipment's associated wiring, including conductors, cables, exposed conduit, surface metal raceways, boxes, and fittings, back to equipment's power source as indicated.

3.1.12.4 Continuation of Service

Maintain continuity of existing circuits of equipment to remain. Maintain existing circuits of equipment energized. Restore circuits wiring and power which are to remain but were disturbed during demolition back to original condition.

3.2 FIELD FABRICATED NAMEPLATE MOUNTING

Provide number, location, and letter designation of nameplates as indicated. Fasten nameplates to the device with a minimum of two sheet-metal screws or two rivets.

3.3 WARNING SIGN MOUNTING

Provide the number of signs required to be readable from each accessible side. Space the signs in accordance with [NFPA 70E](#).

3.4 FIELD QUALITY CONTROL

Furnish test equipment and personnel and submit written copies of test results. Give Contracting Officer 5 working days notice prior to each test [s](#). Where applicable, test electrical equipment in accordance with [NETA ATS](#).

3.4.1 Devices Subject to Manual Operation

Operate each device subject to manual operation at least five times, demonstrating satisfactory operation each time.

3.4.2 600-Volt Wiring Test

Test wiring rated 600 volt and less to verify that no short circuits or accidental grounds exist. Perform insulation resistance tests on wiring No. 6 AWG and larger diameter using instrument which applies voltage of 1,000 volts DC for 600 volt rated wiring and 500 volts DC for 300 volt rated wiring per [NETA ATS](#) to provide direct reading of resistance. All existing wiring to be reused must also be tested.

3.4.3 Grounding System Test

Test grounding system to ensure continuity, and that resistance to ground is not excessive. Test each ground rod for resistance to ground before making connections to rod; tie grounding system together and test for resistance to ground. Make resistance measurements in dry weather, not earlier than 48 hours after rainfall. Submit written results of each test

to Contracting Officer, and indicate location of rods as well as resistance and soil conditions at time measurements were made.

3.4.4 Phase Rotation Test

Perform phase rotation test to ensure proper rotation of service power prior to operation of new or reinstalled equipment using a phase rotation meter. Follow the meter manual directions performing the test.

-- End of Section --

SECTION 26 23 00.00 40

SWITCHBOARDS AND SWITCHGEAR
11/17

PART 1 GENERAL

1.1 PRODUCT COORDINATION

Products and materials that are not considered to be switchboards and related accessories are specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C12.1 (2014; Errata 2016) Electric Meters - Code for Electricity Metering

ASTM INTERNATIONAL (ASTM)

ASTM A123/A123M (2017) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

ASTM A153/A153M (2016a) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware

ASTM A653/A653M (2020) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

ASTM A780/A780M (2020) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings

ASTM D149 (2020) Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies

ASTM D709 (2017) Standard Specification for Laminated Thermosetting Materials

ASTM D1535 (2014; R 2018) Standard Practice for Specifying Color by the Munsell System

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 81 (2012) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth

Surface Potentials of a Ground System

- IEEE C2 (2017; Errata 1-2 2017; INT 1 2017)
National Electrical Safety Code
- IEEE C37.20.1A (2020) Metal-Enclosed Low-Voltage (1000
Vac and below, 3200 Vdc and below) Power
Circuit-Breaker Switchgear Amendment 1:
Control and Secondary Circuits and
Devices, and All Wiring
- IEEE C57.12.28 (2014) Standard for Pad-Mounted Equipment
- Enclosure Integrity
- IEEE C57.13 (2016) Standard Requirements for
Instrument Transformers
- IEEE Stds Dictionary (2009) IEEE Standards Dictionary: Glossary
of Terms & Definitions

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

- NETA ATS (2021) Standard for Acceptance Testing
Specifications for Electrical Power
Equipment and Systems

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

- ANSI/NEMA PB 2.1 (2013) General Instructions for Proper
Handling, Installation, Operation and
Maintenance of Deadfront Distribution
Switchboards Rated 600 V or Less
- NEMA ICS 6 (1993; R 2016) Industrial Control and
Systems: Enclosures
- NEMA LI 1 (1998; R 2011) Industrial Laminating
Thermosetting Products
- NEMA PB 2 (2011) Deadfront Distribution Switchboards

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

- NFPA 70 (2020; ERTA 20-1 2020; ERTA 20-2 2020;
ERTA 20-3 2020; TIA 20-1; TIA 20-2; TIA
20-3; TIA 20-4; TIA 20-5; TIA 20-6; TIA
20-7; TIA 20-8; TIA 20-9; TIA 20-10; TIA
20-11; TIA 20-12; TIA 20-13; TIA 20-14;
TIA 20-15; TIA 20-16; ERTA 20-4 2022)
National Electrical Code

UNDERWRITERS LABORATORIES (UL)

- UL 467 (2022) UL Standard for Safety Grounding
and Bonding Equipment
- UL 489 (2016; Rev 2019) UL Standard for Safety
Molded-Case Circuit Breakers, Molded-Case
Switches and Circuit-Breaker Enclosures

UL 891	(2019) UL Standard for Safety Switchboards
UL 1558	(2016; Reprint Nov 2019) UL Standard for Safety Metal-Enclosed Low-Voltage Power Circuit Breaker Switchgear

1.3 DEFINITIONS

Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, are as defined in IEEE Stds Dictionary.

1.4 SUBMITTALS

Government approval is required for submittals. Submit the following in accordance with the design build contractor's SATOC Task Order:

SD-02 Shop Drawings

Switchboard Drawings

SD-03 Product Data

Switchboard

SD-06 Test Reports

Acceptance Checks and Tests

SD-07 Certificates

Equipment Test Schedule

Switchboard Design Tests

SD-10 Operation and Maintenance Data

Switchboard Operation and Maintenance, Data Package 5

SD-11 Closeout Submittals

Warranty

Assembled Operation and Maintenance Manuals

Request for Settings

1.5 QUALITY CONTROL

1.5.1 Switchboard Product Data

Include on each submittal the manufacturer's information for each component, device and accessory provided with the switchboard including the following:

- a. Circuit breaker type, interrupting rating, and trip devices, including available settings

- b. Manufacturer's instruction manuals and published time-current curves (on full-size logarithmic paper) of the main secondary breaker and largest secondary feeder device

1.5.2 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Ensure that equipment, materials, installation, and workmanship are in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated.

1.5.3 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products that are of equal material, design and workmanship. Ensure that the products have been in satisfactory commercial or industrial use for 2 years before bid opening. The 2-year period includes applications of equipment and materials under similar circumstances and of similar size. Use products that have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Where two or more items of the same class of equipment are required, use products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

1.5.3.1 Alternative Qualifications

Products having less than a 2-year field service record are acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

1.5.3.2 Material and Equipment Manufacturing Date

Do not use products manufactured more than 3 years before the date of delivery to the site, unless specified otherwise.

1.6 WARRANTY

Provide the Contracting Officer with warranties associated with the equipment. Ensure that the equipment items are supported by service organizations that are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

PART 2 PRODUCTS

2.1 DESIGN REQUIREMENTS

Show wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items to ensure a coordinated installation.

2.1.1 Switchboard Drawings

Drawings include the following:

- a. One-line diagram, including breakers, current transformers, and meters
- b. Outline drawings, including front elevation, section views, footprint, and overall dimensions
- c. Bus configuration, including dimensions and ampere ratings of bus bars
- d. Markings and NEMA nameplate data.
- e. Circuit breaker type, interrupting rating, and trip devices, including available settings
- f. Three-line diagrams, elementary diagrams, and wiring diagrams. with terminals identified and indicating prewired interconnections between items of equipment and the interconnection between the items.
- g. Manufacturer's instruction manuals and published time-current curves (on full-size logarithmic paper) of the main secondary breaker and largest secondary feeder device.

2.1.2 Ratings

The voltage rating of the switchboard is 480Y/277 volts AC, 4-wire 3 phase. The continuous-current rating of the main bus is as indicated. The short-circuit current rating is as indicated. Provide a switchboard that is UL-listed and labeled for its intended use.

2.2 COMPONENTS

Provide SWITCHBOARD that conforms to NEMA PB 2 and UL 891, IEEE C37.20.1A and UL 1558.

2.2.1 Construction

Provide dead front switchboards conforming to NEMA PB 2 and labeled under UL 891. Ensure that the switchboards are completely enclosed self-supporting metal structures with the required number of vertical panel sections, buses, molded-case circuit breakers as shown on the drawings. Provide switchboards that are fully rated for a short-circuit current as indicated on drawings..

Switchboard consists of vertical sections bolted together to form a rigid assembly and is front- and rear- aligned. All circuit breakers are front-accessible. Front- and rear-aligned switchboards have rear-accessible load connections. Ensure that compartmentalized switchboards have vertical insulating barriers between the front device section, the main bus section, and the cable compartment. Where indicated, "space for future" or "space" means to include bus, device supports, and connections. Provide insulating barriers in accordance with NEMA LI 1, Type GPO-3, 0.25 inch minimum thickness. Apply moisture-resistant coating to all rough-cut edges of barriers. Provide a switchboard that is completely factory-engineered and factory-assembled, including protective devices and equipment indicated with necessary interconnections, instrumentation, and control wiring.

2.2.1.1 Enclosure

Ensure that the switchboard enclosure is **NEMA ICS 6** Type 1 . Bolt the enclosure together with removable bolt-on side and hinged rear covers. Provide front doors with padlockable vault handles with a three-point catch. Ensure that bases, frames and channels of enclosure are corrosion resistant and fabricated of galvanized steel. Base includes any part of enclosure that is within **3 inches** of concrete pad. Galvanized steel conforms to **ASTM A123/A123M**, **ASTM A653/A653M** G90 coating, and **ASTM A153/A153M**, as applicable. Galvanize after fabrication where practicable. Paint the enclosure, including the bases, **ASTM D1535** light gray No. 61 or No. 49. Ensure that the paint coating system complies with **IEEE C57.12.28** for galvanized steel.

2.2.1.2 Bus Bars

Ensure that the bus bars are copper with silver-plated contact surfaces. Ensure that plating is at least **0.0002 inches** thick. Make bus connections and joints with hardened-steel bolts. Rate the through-bus at the full ampacity of the main throughout the switchboard. Provide a copper ground bus at least **0.25 inch by 2 inches** secured to each vertical section along the entire length of the **switchboard**. Rate the neutral bus 100 percent of the main bus continuous-current rating. Insulate bus bars with an epoxy finish coating powder providing a minimum breakdown voltage of 16,000 volts in accordance with **ASTM D149**.

2.2.1.3 Main Section

The main section **shall be a main lug pull section**. .

2.2.1.4 Distribution Sections

The distribution sections consist of molded-case circuit breakers as indicated.

2.2.2 Protective Device

Provide main and branch protective devices as indicated.

2.2.2.1 Molded-Case Circuit Breaker

Provide breakers conforming to **UL 489**. Ensure that breakers are UL-listed and labeled, stationary, manually operated, low-voltage molded-case circuit breaker, with a short-circuit current rating **as shown on drawings**. Breaker frame size is as indicated. Series-rated circuit breakers are unacceptable.

Equip each switchboard with molded-case circuit breakers with trip ratings and terminal connectors for attachment of outgoing power cables as shown on the drawings. Ensure that the circuit breakers are operable and removable from the front. Where shown on the drawings, enclose circuit breakers in individual compartments.

2.2.3 Electronic Trip Units

Equip main and distribution breakers with a solid-state tripping system consisting of three current sensors and a microprocessor-based trip unit that provides true RMS-sensing adjustable time-current circuit protection. The ampere rating of the current sensors are as indicated.

The trip unit ampere rating is as indicated. Ground fault protection is as indicated. Provide the electronic trip units with the following features as indicated.

- a. Breakers have long-delay pickup and time settings, and LED indication of cause of circuit breaker trip.
- b. Main breakers have short-delay pickup and time settings and, instantaneous settings and ground fault settings.
- c. Distribution breakers have short-delay pickup and time settings, instantaneous settings.

2.2.4 Electronic Trip Unit Central Monitor

Provide a microprocessor-based device designed to monitor and display parameters of the circuit breaker electronic trip units. Ensure that the central monitor has the following features:

- a. Alphanumeric display
- b. Indication of circuit breaker status: tripped, open, closed
- c. Cause of circuit breaker trip
- d. Phase, neutral, and ground current for each breaker
- e. Energy parameters for each breaker
- f. Provisions for communicating directly to a remote computer

2.2.5 Instruments

Provide electrical indicating switchboard instruments, with 2-percent accuracy. Provide ac ammeters and voltmeters at least 2 inches square, with a 250-degree scale. Provide single-phase indicating instruments with flush-mounted transfer switches for reading three phases.

2.2.5.1 AC Ammeters

Provide a self-contained, 0-to-as indicated-ampere scale range, 60 hertz.

2.2.5.2 AC Voltmeters

Provide self-contained voltmeters.

2.2.5.3 Instrument Control Switches

Provide rotary cam-operated instrument control switches with positive means of indicating contact positions. Ensure that switches have silver-to-silver contacts enclosed in a protective cover that can be removed to inspect the contacts.

2.2.6 Current Transformers

Provide transformers that conform to IEEE C57.13. Ensure that transformers are single-ratio, 60 hertz, as required to 5-ampere ratio, as required rating factor, with a metering accuracy class of 0.3 through as required.

2.2.7 Meter Fusing

Provide a fuse block-mounted in the metering compartment, containing one fuse per phase to protect the voltage input to voltage sensing meters. Size the fuses as recommended by the meter manufacturer.

2.2.8 Terminal Boards

Provide terminal boards with engraved plastic terminal strips and screw terminals for external wiring between components and for internal wiring between removable assemblies. Ensure that the terminal boards associated with current transformers are short-circuiting type. Terminate conductors for current transformers with ring-tongue lugs. Ensure that the terminal board identification is identical in similar units. Color-code external wiring consistently for similar terminal boards.

2.2.9 Wire Marking

Mark the control and metering conductors at each end. Provide factory-installed, white, plastic tubing, heat-stamped with black block letters on factory-installed wiring. On field-installed wiring, provide white, preprinted, polyvinyl chloride (PVC) sleeves, heat-stamped with black block letters. Ensure that each sleeve contains a single letter or number, is elliptically shaped to securely grip the wire, and is keyed to align with the adjacent sleeves. Provide specific wire markings using the appropriate combination of individual sleeves. Ensure that each wire marker indicates the device or equipment, including the specific terminal number to which the remote end of the wire is attached.

2.2.10 Manufacturer's Nameplate

Ensure that each item of equipment has a nameplate bearing the manufacturer's name, address, model number, and serial number, securely affixed in a conspicuous place. The nameplate of the distributing agent is not acceptable. This nameplate and method of attachment may be the manufacturer's standard if it contains the required information.

2.2.11 Field-Fabricated Nameplates

Ensure that nameplates conform to [ASTM D709](#). Provide laminated plastic nameplates for each switchboard, equipment enclosure, relay, switch, and device, as specified in this section or as indicated on the drawings. Ensure that each nameplate inscription identifies the function and, when applicable, the position. Construct the nameplates of melamine plastic, [0.125 inch](#) thick, white with black center core. Provide a red laminated plastic label with a white center core where indicated. Provide a matte finish with square corners. Accurately align lettering and engrave into the core. Ensure that nameplates measure at least [1 inch by 2.5 inches](#). Provide block lettering at least [0.25 inch](#) high.

2.3 TESTS, INSPECTIONS, AND VERIFICATIONS

2.3.1 [Equipment Test Schedule](#)

The Government reserves the right to witness tests. Provide schedules for equipment to be tested at the manufacturer's test facility. Submit required test schedule and location, and notify the Contracting Officer 30 calendar days before the scheduled test date. Notify the Contracting Officer 15 calendar days before changes to the scheduled test date.

a. Test Instrument Calibration Requirements

- (1) The manufacturer has a calibration program ensuring that all applicable test instruments are maintained within rated accuracy.
- (2) The accuracy is directly traceable to the National Institute of Standards and Technology.
- (3) The instrument calibration frequency schedule cannot exceed 12 months for both test floor instruments and leased specialty equipment.
- (4) Dated calibration labels are visible on all test equipment.
- (5) The calibrating standard is of higher accuracy than that of the instrument tested.
- (6) Records that indicate dates and test results of instruments calibrated or tested are kept up to date. For instruments calibrated by the manufacturer on a routine basis, in lieu of third-party calibration, the following are included:
 - (a) Up-to-date instrument calibration instructions and procedures for each test instrument
 - (b) Identification of instruments calibrated by a third party or laboratory to verify that the calibrating standard is met

2.3.2 Switchboard Design Tests

NEMA PB 2 and UL 891.

2.3.2.1 Design Tests

Furnish documentation showing the results of design tests on a product of the same series and rating as that provided by this specification.

- a. Short-circuit current test
- b. Enclosure tests
- c. Dielectric test

PART 3 EXECUTION

3.1 INSTALLATION

Ensure that the electrical installations conform to IEEE C2, NFPA 70, and to the requirements specified herein.

3.1.1 Grounding

Meet the requirements of NFPA 70 and IEEE C2, except that grounds and grounding systems have a resistance to solid earth ground not exceeding 5 ohms.

3.1.1.1 Equipment Grounding

Provide bare copper cable not smaller than No. 4/0 AWG and not less than 24-inches below grade connecting to the indicated ground rods. When work in addition to that indicated or specified is directed in order to obtain the specified ground resistance, the provision of the Contract covering "Changes" applies.

3.1.1.2 Connections

Make the joints in grounding conductors and loops by exothermic weld or compression connector.

3.1.1.3 Grounding and Bonding Equipment

Ensure that the equipment conforms to UL 467, except as indicated or otherwise specified.

3.1.2 Installation of Equipment and Assemblies

Install and connect equipment furnished under this section as indicated on approved project or shop drawings and as specified herein.

3.1.2.1 Switchboard

ANSI/NEMA PB 2.1.

3.1.2.2 Meters and Instrument Transformers

ANSI C12.1.

3.1.2.3 Field-Applied Painting

Where field painting of enclosures is necessary to correct damage to the manufacturer's factory-applied coatings, provide the manufacturer's recommended coatings and apply in accordance with the manufacturer's instructions.

3.1.2.4 Galvanizing Repair

Repair damage to galvanized coatings in conformance with ASTM A780/A780M, using zinc-rich paint, for galvanizing surfaces damaged by handling, transporting, cutting, welding, or bolting. Do not heat surfaces that the repair paint has been applied to.

3.1.2.5 Field-Fabricated Nameplate Mounting

Provide the number, location, and letter designation of nameplates as indicated. Fasten nameplates to the device with a minimum of two sheet-metal screws or two rivets.

3.1.3 Foundation For Equipment And Assemblies

3.1.3.1 Interior Location

Mount the switchboard on the concrete slab. Unless otherwise indicated, ensure that the slab is at least 4 inches thick. Place the top of the concrete slab approximately 4 inches above the finished floor. Form edges above the floor to have a 0.5 inch chamfer. Size the slab to project at

least 8 inches beyond the equipment. Provide conduit turnups and cable entrance space required by the equipment to be mounted. Seal voids around conduit openings in the slab with water- and oil-resistant caulking or sealant. Cut off and bush conduits 3 inches above the slab surface.

3.2 FIELD QUALITY CONTROL

Submit a request for settings of breakers to the Contracting Officer after approval of the switchboard and at least 30 days before their requirement.

3.2.1 Performance of Acceptance Checks and Tests

Perform tests in accordance with the manufacturer's recommendations and include the following visual and mechanical inspections and electrical tests, performed in accordance with NETA ATS.

3.2.1.1 Switchboard Assemblies

a. Visual and Mechanical Inspection

- (1) Compare equipment nameplate data with specifications and approved shop drawings.
- (2) Inspect physical, electrical, and mechanical condition.
- (3) Confirm correct application of manufacturer's recommended lubricants.
- (4) Verify appropriate anchorage, required area clearances, and correct alignment.
- (5) Inspect all doors, panels, and sections for paint, dents, scratches, fit, and missing hardware.
- (6) Verify that circuit breaker sizes and types correspond to approved shop drawings.
- (7) Verify that current transformer ratios correspond to approved shop drawings.
- (8) Inspect all bolted electrical connections for high resistance using a low-resistance ohmmeter, verifying tightness of accessible bolted electrical connections by using the calibrated torque-wrench method or performing a thermographic survey.
- (9) Confirm correct operation and sequencing of electrical and mechanical interlock systems.
- (10) Clean switchboard.
- (11) Inspect insulators for evidence of physical damage or contaminated surfaces.
- (12) Verify correct barrier installation.
- (13) Exercise all active components.
- (14) Inspect all mechanical indicating devices for correct operation.

- (15) Verify that vents are clear.
- (16) Test the operation, alignment, and penetration of instrument transformer withdrawal disconnects.
- (17) Inspect control power transformers.

b. Electrical Tests

- (1) Perform insulation-resistance tests on each bus section.
- (2) Perform overpotential tests.
- (3) Perform insulation-resistance test on control wiring; do not perform this test on wiring connected to solid-state components.
- (4) Perform control wiring performance test.
- (5) Perform primary current injection tests on the entire current circuit in each section of assembly.

3.2.1.2 Circuit Breakers

Low-Voltage Molded-Case with Solid-State Trips

a. Visual and Mechanical Inspection

- (1) Compare nameplate data with specifications and approved shop drawings.
- (2) Inspect circuit breaker for correct mounting.
- (3) Operate circuit breaker to verify smooth operation.
- (4) Inspect case for cracks or other defects.
- (5) Inspect all bolted electrical connections for high resistance using low-resistance ohmmeter, verifying tightness of accessible bolted connections or cable connections by using the calibrated torque-wrench method or performing a thermographic survey.
- (6) Inspect mechanism contacts and arc chutes in unsealed units.

b. Electrical Tests

- (1) Perform contact-resistance tests.
- (2) Perform insulation-resistance tests.
- (3) Perform breaker adjustments for final settings in accordance with Government-provided settings.
- (4) Perform long-time-delay time-current characteristic tests.
- (5) Determine short-time pickup and delay by primary current injection.
- (6) Determine ground fault pickup and time delay by primary current injection.

- (7) Determine instantaneous pickup current by primary injection.
- (8) Verify correct operation of any auxiliary features such as trip and pickup indicators, zone interlocking, electrical close and trip operation, trip-free, and antipump function.

3.2.1.3 Current Transformers (CTs)

a. Visual and Mechanical Inspection

- (1) Compare equipment nameplate data with specifications and approved shop drawings.
- (2) Inspect physical and mechanical condition.
- (3) Verify correct connection.
- (4) Verify that adequate clearances exist between primary and secondary circuit.
- (5) Inspect all bolted electrical connections for high resistance using low-resistance ohmmeter, verifying tightness of accessible bolted electrical connections by using the calibrated torque-wrench method or performing a thermographic survey.
- (6) Verify that all required grounding and shorting connections provide good contact.

b. Electrical Tests

- (1) Perform resistance measurements through all bolted connections with low-resistance ohmmeter, if applicable.
- (2) Perform insulation-resistance tests.
- (3) Perform polarity tests.
- (4) Perform ratio-verification tests.

3.2.1.4 Metering and Instrumentation

a. Visual and Mechanical Inspection

- (1) Compare equipment nameplate data with specifications and approved shop drawings.
- (2) Inspect physical and mechanical condition.
- (3) Verify tightness of electrical connections.

b. Electrical Tests

- (1) Determine accuracy of meters at 25, 50, 75, and 100 percent of full scale.
- (2) Calibrate watthour meters according to the manufacturer's published data.
- (3) Verify all instrument multipliers.

- (4) Electrically confirm that current transformer and voltage transformer secondary circuits are intact.

3.2.1.5 Grounding System

a. Visual and Mechanical Inspection

- (1) Inspect ground system for compliance with contract plans and specifications.

b. Electrical Tests

- (1) Perform tests in conformance with **IEEE 81**. Measure ground impedance, using the fall-of-potential method. On systems consisting of interconnected ground rods, perform tests after interconnections are complete. On systems consisting of a single ground rod, perform tests before any wire is connected. Take measurements in normally dry weather, not less than 48 hours after rainfall. Use a portable ground testing megger in accordance with the manufacturer's instructions to test each ground or group of grounds. Ensure that the instrument is equipped with a meter reading directly in ohms or fractions thereof to indicate the ground value of the ground rod or grounding systems under test.
- (2) Submit the measured ground resistance of each ground rod and grounding system, indicating the location of the rod and grounding system. Include the test method and test setup (that is, pin location) used to determine ground resistance and soil conditions at the time the measurements were made.

3.2.2 Follow-Up Verification

Upon completion of acceptance checks, settings, and tests, show by demonstration in service that circuits and devices are in good operating condition and properly performing the intended function. Trip circuit breakers by operation of each protective device. Testing requires each item to perform its function not less than three times. Submit test results to the Contracting Officer. As an exception to requirements stated elsewhere in the contract, notify the Contracting Officer of the dates and times for checks, settings, and tests 5 working days in advance.

3.3 CLOSEOUT ACTIVITIES

3.3.1 **Switchboard Operation and Maintenance Data**

Submit operation and maintenance manuals in accordance with Section **01 78 23** OPERATION AND MAINTENANCE DATA.

3.3.2 **Assembled Operation and Maintenance Manuals**

Assemble and bind manuals securely in durable, hard-covered, water-resistant binders. Assemble and index the manuals in the following order with a table of contents

- a. Manufacturer's O&M information required by paragraph SD-10 OPERATION AND MAINTENANCE DATA
- b. Catalog data required by paragraph SD-03 PRODUCT DATA

- c. Drawings required by paragraph SD-02 SHOP DRAWINGS
 - d. Prices for spare parts and supply list
 - e. Information on metering
 - f. Design test reports
 - g. Production test reports
- End of Section --

SECTION 26 28 01.00 10

COORDINATED POWER SYSTEM PROTECTION
08/21

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 242 (2001; Errata 2003) Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems - Buff Book

IEEE 399 (1997) Brown Book IEEE Recommended Practice for Power Systems Analysis

1.2 SYSTEM DESCRIPTION

The power system covered by this specification consists of: **Establishment of a coordinated power system from the existing utility transformer to the new emergency power switchboard..**

1.3 SUBMITTALS

Government approval is required for submittals. Submit the following in accordance with **the design build contractor's SATOC Task Order:**

SD-03 Product Data

Fault Current Analysis

Protective Device Coordination Study

System Coordinator

1.4 QUALITY ASSURANCE

1.4.1 **System Coordinator**

System coordination, recommended ratings and settings of protective devices, and design analysis must be accomplished by a registered professional electrical power engineer with a minimum of 3 years of current experience in the coordination of electrical power systems. Submit verification of experience and license number, of a registered Professional Engineer as specified above. Provide experience data consisting of at least five references for work of a magnitude comparable to this contract, including points of contact, addresses and telephone numbers.

PART 2 PRODUCTS

2.1 COORDINATED POWER SYSTEM PROTECTION

Prepare analyses to demonstrate that the equipment selected and system constructed meet the contract requirements for ratings, coordination, and protection. Include a load flow analysis, a [fault current analysis](#), and a [protective device coordination study](#). Submit the study along with protective device equipment submittals. No time extensions or similar contact modifications will be granted for work arising out of the requirements for this study. Approval of protective devices proposed will be based on recommendations of this study. The Government is not responsible for any changes to equipment, device ratings, settings, or additional labor for installation of equipment or devices ordered and/or procured prior to approval of the study. The studies must be performed by a registered professional engineer with demonstrated experience in power system coordination in the last 3 years. Provide a list of references complete with points of contact, addresses and telephone numbers. The selection of the engineer is subject to the approval of the Contracting Officer.

2.1.1 Scope of Analyses

The fault current analysis and protective device coordination study must begin at: the source bus and extend down to system buses where fault availability is 10,000 amperes (symmetrical) for building/facility 600 volt level distribution buses.

2.1.2 Determination of Facts

Determine and document the time-current characteristics, features, and nameplate data for each existing protective device. Coordinate with the commercial power company for fault current availability at the site.

2.1.3 Single Line Diagram

Prepare a single line diagram to show the electrical system buses, devices, transformation points, and all sources of fault current (including generator and motor contributions). A fault-impedance diagram or a computer analysis diagram may be provided. Each bus, device or transformation point must have a unique identifier. If a fault-impedance diagram is provided, show impedance data. Show location of switches, breakers, and circuit interrupting devices on the diagram together with available fault data, and the device interrupting rating.

2.1.4 Fault Current Analysis

2.1.4.1 Method

Perform the fault current analysis in accordance with methods described in [IEEE 242](#), and [IEEE 399](#).

2.1.4.2 Data

Utilize actual data in fault calculations. Bus characteristics and transformer impedance must be those proposed. Document data in the report.

2.1.4.3 Fault Current Availability

Provide balanced three-phase fault, bolted line-to-line fault, and

line-to-ground fault current values at each voltage transformation point and at each power distribution bus. Show the maximum and minimum values of fault available at each location in tabular form on the diagram or in the report.

2.1.5 Coordination Study

Demonstrate that the maximum possible degree of selectivity has been obtained between devices specified, consistent with protection of equipment and conductors from damage from overloads and fault conditions. Include a description of the coordination of the protective devices in this project. Provide a written narrative describing: which devices may operate in the event of a fault at each bus; the logic used to arrive at device ratings and settings; situations where system coordination is not achievable due to device limitations (an analysis of any device curves which overlap); coordination between upstream and downstream devices; and relay settings. Provide recommendations to improve or enhance system reliability, and detail where such changes would involve additions or modifications to the contract and cost damages (addition or reduction). Provide composite coordination plots on log-log graph paper.

2.1.6 Study report

- a. Include a narrative describing: the analyses performed; the bases and methods used; and the desired method of coordinated protection of the power system.
- b. Include descriptive and technical data for existing devices and new protective devices proposed. Include manufacturers published data, nameplate data, and definition of the fixed or adjustable features of the existing or new protective devices.
- c. Document utility company data including system voltages, fault MVA, system X/R ratio, time-current characteristic curves, current transformer ratios, and relay device numbers and settings; and existing power system data including time-current characteristic curves and protective device ratings and settings.
- d. The report must contain fully coordinated composite time-current characteristics curves for each bus in the system, as required to ensure coordinated power system protection between protective devices or equipment. Include recommended ratings and settings of all protective devices in tabulated form.
- e. Provide the calculation performed for the analyses, including computer analysis programs utilized. Provide the name of the software package, developer, and version number.

PART 3 EXECUTION

Not Used

-- End of Section --

SECTION 26 28 21.00 40

AUTOMATIC TRANSFER SWITCHES
05/17

PART 1 GENERAL

Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM applies to work specified in this section.

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250 (2020) Enclosures for Electrical Equipment
(1000 Volts Maximum)

NEMA ICS 10 Part 2 (2020) Industrial Control and Systems,
Part 2: Static AC Transfer Equipment

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (2020; ERTA 20-1 2020; ERTA 20-2 2020;
ERTA 20-3 2020; TIA 20-1; TIA 20-2; TIA
20-3; TIA 20-4; TIA 20-5; TIA 20-6; TIA
20-7; TIA 20-8; TIA 20-9; TIA 20-10; TIA
20-11; TIA 20-12; TIA 20-13; TIA 20-14;
TIA 20-15; TIA 20-16; ERTA 20-4 2022)
National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 508 (2018; Reprint Jul 2021) UL Standard for
Safety Industrial Control Equipment

UL 1008 (2014) Transfer Switch Equipment

1.2 SUBMITTALS

Government approval is required for submittals. Submit the following in accordance with the design build contractor's SATOC Task Order:

SD-02 Shop Drawings

Connection Diagrams

Fabrication Drawings

Installation Drawings

SD-03 Product Data

Equipment and Performance Data

Contacts

Indicating Lights

Terminal Board

Enclosures

SD-06 Test Reports

Qualification Testing

Operation Tests

SD-07 Certificates

Listing of Product Installations

SD-08 Manufacturer's Instructions

Manufacturer's Instructions

1.3 QUALITY CONTROL

1.3.1 Product Installations

Submit [listing of product installations](#) for automatic transfer switches showing the manufacturer has successfully manufactured automatic transfer switches of the size specified for a minimum period of 10 years. Include on the list, purchaser, address of installation, service organization, and date of installation.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

Provide an automatic transfer switch with a time-delay feature that is field-adjustable from 2 to 30 minutes. The switch delays the automatic transfer back to normal power until the normal source voltage and frequency reach at least 95 percent of the rated voltage. However, if the emergency power fails and the normal source is again available at 90 percent of the rated voltage, bypass the time-delay circuitry, and transfer the load immediately back to the normal source. Provide the capability for manual transfer in either direction. Operate sensing relays without contact chatter or false response during voltage variations between dropout and pickup.

Submit [connection diagrams](#) showing the relations and connections of contacts, indicating lights, and terminal board by showing the general physical layout of all controls and the interconnection of one system (or portion of system) with another.

Submit [fabrication drawings](#) for contacts, indicating lights, terminal board enclosures, and accessories, consisting of fabrication and assembly details to be performed in the factory.

Submit [installation drawings](#) for automatic transfer equipment in accordance with paragraph INSTALLATION.

Submit [equipment and performance data](#) for automatic transfer equipment including useful life, test, system functional flows, safety features, and mechanical automated details.

2.1.1 Performance Requirements

2.1.1.1 Application

Provide an automatic transfer switch capable of transferring the load from the normal power source to emergency power source, and from an emergency source to the normal power source. Locate the switch where indicated. Provide a switch that is solenoid-operated, mechanically held, double-throw, rated for continuous duty, capable of transferring in 100 milliseconds or less, and conforming to the applicable requirements of [UL 1008](#) and [NFPA 70](#), Article 700, except as herein modified.

Provide an automatic transfer switch of the two-pole type for single-phase application, and three-pole type for three-phase application. Provide a solid neutral conductor connection for neutral transfer from the normal source to the emergency source.

Ensure that the automatic transfer switch is capable of being placed in either the normal or the emergency position.

2.1.1.2 Operation

Monitor the normal source voltage across phase lines by sensing devices. If the normal source voltage in phase drops to 90 percent or less for a timed period, ensure that the automatic transfer switch starts the emergency source and transfers the load to the emergency source when voltage and frequency reach rated values; or, if the emergency source is on, verify the voltage and frequency of the alternate source and transfer the load to the alternate source. Field-adjust this time period from 1 to 30 seconds. Provide a voltage and frequency sensor relay to monitor the rated values on the emergency side to prohibit transfer until the emergency source voltage and frequency reach at least 95 percent of the required rating. Provide phase failure protection, with a 65- to 70-percent drop and a 92- to 95-percent voltage pickup rating.

2.1.1.3 Self-Test Capability

Provide an automatic transfer switch with a control-circuit self-test feature capable of verifying the proper operation of the switch control circuit without moving the main contactor or causing discontinuity of service to the load. Include the following characteristics in the self-test circuit:

- a. A key-operated test switch that includes an auto, off, no-load engine test and a load test position. Include a white light to indicate that the switch is in the off position. Ensure that the transfer switch controller includes a programmable engine exerciser with the following selections: Disabled; 7-, 14- and 28-day intervals; and 15 minutes fixed time, load or no load with Failsafe. Design the key-operated switch to prevent removal of the key while the switch is in the self-test mode.

OR

- b. A power-failure simulator switch that removes voltage from the

voltage-sensing devices so that emergency power activates the test light.

2.2 COMPONENTS

2.2.1 **Contacts**

Provide main contacts with a wiping-action silver alloy that, when rated for operation at 50 amperes or greater, are protected against arcing. Ensure that auxiliary contacts and control transfer relay contacts have a minimum continuous-current rating of not less than 10-amperes inductive at 120 volts ac. Provide the following for auxiliary contacts:

- a. Generator-control contacts, normally open, that close on undervoltage or loss of normal power as specified, remaining closed until transfer back to normal power
- b. Emergency-position contacts, normally open when the switch is in the normal position, that close when the switch is in the emergency position
- c. An automatic transfer switch with a switched neutral. Ensure that the switched neutral has: normal position contacts that are normally closed when the switch is in the normal position and opens when the switch is in the emergency position. Ensure that the neutral pole is fully rated and part of the main pole assembly, so that it is switched simultaneously with the main bus contacts.

Use two-pole auxiliary contacts.

Provide a test automatic transfer switch mounted as shown on drawings with contacts rated for operation at 10 amperes.

Provide an automatic transfer switch with overlapping neutral transfer contacts in addition to the two- or three-pole main bus contacts. Ensure that normal and emergency neutral contacts are connected together only during the transfer and retransfer operation. Ensure contacts remain connected only until the power source contacts close/open to transfer from one source to the other. Ensure that the connection time of the overlapping neutral transfer contacts does not exceed 100 milliseconds.

2.2.2 **Indicating Lights**

Furnish an automatic transfer switch with two indicating lamps: one light to indicate that the switch is operating on normal power, and the other light to indicate that the switch is operating on emergency power. Fuse each indicating circuit.

2.2.3 **Terminal Board**

Provide a contactor automatic transfer switch terminal board for internally wired control devices, indicating lights, auxiliary contacts, and internal control devices or auxiliary switches to a common output terminal board. Wire the internal functions to facilitate remote connections or monitoring.

2.2.4 **Microprocessor Control Panel**

Provide a control panel to direct the operation of the transfer switch.

Connect the panel to the transfer switch with an interconnecting wiring harness. Include with the harness a disconnect plug for transfer switch routine maintenance.

Enclose the control panel with a protective cover and mount separately from the transfer switch. Provide plug-in type interfacing relays.

2.2.5 Enclosures

Provide an automatic transfer switch enclosure with solid, code-gage, 14-gage, minimum sheet metal, NEMA 250, Type 1, with the manufacturer's standard finish.

2.3 TESTS, INSPECTIONS, AND VERIFICATIONS

2.3.1 Qualification Testing

Provide test data for the furnished unit or an identical unit. Ensure tests meet the general use requirements of UL 508. Subject the complete automatic transfer switch to a test as outlined in NEMA ICS 10 Part 2. One cycle of operation tests under the UL 508 test requirements consists of a transfer of load from the normal source to the emergency source and retransfer to the normal source. Test the switch operating time and the sense relay pickup and dropout times.

PART 3 EXECUTION

3.1 INSTALLATION

Install automatic transfer switches as indicated, and in accordance with the manufacturer's instructions. Fully align and install wall-mounted enclosures at the indicated mounting height using a minimum of six 3/8-inch bolts. Do not use sheet metal screws or small machine screws.

3.2 FIELD QUALITY CONTROL

Demonstrate the automatic transfer switch operates in accordance with the specification requirements in conjunction with the normal and emergency power sources.

-- End of Section --

SECTION 26 32 15.00

ENGINE-GENERATOR SET STATIONARY 15-2500 KW, WITH AUXILIARIES
05/20

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.3	(2021) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.5	(2020) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B16.11	(2016) Forged Fittings, Socket-Welding and Threaded
ASME B16.21	(2021) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B31.3	(2020) Process Piping

ASSOCIATION OF EDISON ILLUMINATING COMPANIES (AEIC)

AEIC CS8	(2013) Specification for Extruded Dielectric Shielded Power Cables Rated 5 Through 46 kV

ASTM INTERNATIONAL (ASTM)

ASTM A53/A53M	(2020) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A106/A106M	(2019a) Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service
ASTM A181/A181M	(2014; R 2020) Standard Specification for Carbon Steel Forgings, for General-Purpose Piping
ASTM A193/A193M	(2020) Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service and Other Special Purpose Applications
ASTM A194/A194M	(2022) Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both

ASTM A234/A234M (2019) Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service

ASTM D975 (2020) Standard Specification for Diesel Fuel Oils

ELECTRICAL GENERATING SYSTEMS ASSOCIATION (EGSA)

EGSA 101P (1995) Performance Standard for Engine Driven Generator Sets

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 1 (2000; R 2011) General Principles for Temperature Limits in the Rating of Electric Equipment and for the Evaluation of Electrical Insulation

IEEE 43 (2013) Recommended Practice for Testing Insulation Resistance of Rotating Machinery

IEEE 48 (2020) Test Procedures and Requirements for Alternating-Current Cable Terminations Used on Shielded Cables Having Laminated Insulation Rated 2.5 kV through 765 kV or Extruded Insulation Rated 2.5 kV through 500 kV

IEEE 81 (2012) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System

IEEE 100 (2000; Archived) The Authoritative Dictionary of IEEE Standards Terms

IEEE 115 (2019) Guide for Test Procedures for Synchronous Machines: Part I Acceptance and Performance Testing; Part II Test Procedures and Parameter Determination for Dynamic Analysis

IEEE 120 (1989; R 2007) Master Test Guide for Electrical Measurements in Power Circuits

IEEE 404 (2012) Standard for Extruded and Laminated Dielectric Shielded Cable Joints Rated 2500 V to 500,000 V

IEEE 484 (2019) Recommended Practice for Installation Design and Implementation of Vented Lead-Acid Batteries for Stationary Applications

IEEE 485 (2020) Recommended Practice for Sizing Lead-Acid Batteries for Stationary Applications

- IEEE 519 (2014) Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems
- IEEE C2 (2017; Errata 1-2 2017; INT 1 2017) National Electrical Safety Code
- IEEE C50.12 (2005; R 2010) Standard for Salient Pole 50 HZ and 60 HZ Synchronous Generators and Generation/Motors for Hydraulic Turbine Applications Rated 5 MVA and above

INTERNATIONAL CODE COUNCIL (ICC)

- ICC IBC (2018) International Building Code

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

- NETA ATS (2021) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

- ISO 3046 (2002, 2006, 2009, 2001) Reciprocating Internal Combustion Engines - Performance--Part 1, 3, 4, 5, 6
- ISO 8528 (1993; R 2018) Reciprocating Internal Combustion Engine Driven Alternating Current Generator Sets--Part 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 13

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

- MSS SP-58 (2018) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation
- MSS SP-80 (2019) Bronze Gate, Globe, Angle and Check Valves

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

- NEMA ICS 2 (2000; R 2020) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 V
- NEMA ICS 6 (1993; R 2016) Industrial Control and Systems: Enclosures
- NEMA MG 1 (2016) Motors and Generators - Revision 1: 2018; Includes 2021 Updates to Parts 0, 1, 7, 12, 30, and 31
- NEMA PB 1 (2011) Panelboards

NEMA PB 2 (2011) Deadfront Distribution Switchboards

NEMA WC 74/ICEA S-93-639 (2012) 5-46 kV Shielded Power Cable for Use in the Transmission and Distribution of Electric Energy

NEMA/ANSI C12.11 (2006; R 2019) Instrument Transformers for Revenue Metering, 10 kV BIL through 350 kV BIL (0.6 kV NSV through 69 kV NSV)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 30 (2021; TIA 20-1; TIA 20-2) Flammable and Combustible Liquids Code

NFPA 37 (2021) Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines

NFPA 54 (2021) National Fuel Gas Code

NFPA 58 (2020; TIA 20-1; TIA 20-2; TIA 20-3) Liquefied Petroleum Gas Code

NFPA 70 (2020; ERTA 20-1 2020; ERTA 20-2 2020; ERTA 20-3 2020; TIA 20-1; TIA 20-2; TIA 20-3; TIA 20-4; TIA 20-5; TIA 20-6; TIA 20-7; TIA 20-8; TIA 20-9; TIA 20-10; TIA 20-11; TIA 20-12; TIA 20-13; TIA 20-14; TIA 20-15; TIA 20-16; ERTA 20-4 2022) National Electrical Code

NFPA 110 (2022) Standard for Emergency and Standby Power Systems

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

SAE ARP892 (1965; R 1994) DC Starter-Generator, Engine

SAE J537 (2016) Storage Batteries

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-DTL-16884 (2017; Rev P) Fuel, Naval Distillate

MIL-STD-461 (2015; Rev G) Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

40 CFR 60 Standards of Performance for New Stationary Sources

UNDERWRITERS LABORATORIES (UL)

UL 142 (2006; Reprint Jan 2021) UL Standard for Safety Steel Aboveground Tanks for Flammable and Combustible Liquids

UL 467	(2022) UL Standard for Safety Grounding and Bonding Equipment
UL 489	(2016; Rev 2019) UL Standard for Safety Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures
UL 891	(2019) UL Standard for Safety Switchboards
UL 1236	(2015; Reprint Feb 2021) UL Standard for Safety Battery Chargers for Charging Engine-Starter Batteries
UL 1437	(2006) Electrical Analog Instruments - Panel Board Types

1.2 RELATED MATERIALS

1.3 SUBMITTALS

Government approval is required for submittals. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Engine-Generator Set and Auxiliary Equipment

Auxiliary Systems

Detailed Drawings

Acceptance

SD-03 Product Data

Harmonic Requirements

Engine-Generator Set Efficiencies

Emissions

Filters

Special Tools

Remote Alarm Annunciator

Engine-Generator Parameter Schedule

Generator

Manufacturer's Catalog

Spare Parts

Onsite Training

Vibration-Isolation

Posted Data and Instructions

Experience

Field Engineer

General Installation

Exciter

SD-05 Design Data

Performance Criteria

Sound Limitations

Integral Main Fuel Storage Tank

Power Factor

Heat Exchanger

Time-Delay on Alarms

Cooling System

Vibration Isolation

Battery Charger

Capacity Calculations for Engine-Generator Set

Brake Mean Effective Pressure (BMEP) Calculations

Torsional Vibration Stress Analysis Computations

Capacity Calculations for Batteries

Turbocharger Load Calculations

SD-06 Test Reports

Performance Tests

Factory Inspection and Tests

Factory Tests

Onsite Inspection and Tests

Acceptance Checks and Tests

Functional Acceptance Tests

Maintenance Procedures

Operation and Maintenance Manuals

Inspections

Functional Acceptance Test Procedure

SD-07 Certificates

Cooling System

Vibration Isolation

Prototype Test

Reliability and Durability

Fuel System Certification

Start-Up Engineer

Instructor's Qualification Resume

Engine Emission Limits

Sound Limitations

Site Visit

Current Balance

Materials and Equipment

Factory Inspection and Tests

SD-09 Manufacturer's Field Reports

Engine Tests

Generator Tests

Assembled Engine-Generator Set Tests

SD-10 Operation and Maintenance Data

Preliminary Assembled Operation and Maintenance Manuals

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA and the paragraph ASSEMBLED OPERATION AND MAINTENANCE MANUALS.

SD-11 Closeout Submittals

Posted Data and Instructions

Training Plan

1.4 QUALITY ASSURANCE

1.4.1 Conformance to Codes and Standards

Where equipment is specified to conform to requirements of any code or standard such as UL, NEMA, etc., the design, fabrication and installation must also conform to the code.

1.4.2 Vibration Limitation

Limit the maximum engine-generator set vibration in the horizontal, vertical, and axial directions to **6 mils** (peak-peak RMS), with an overall velocity limit of **0.95 inches/second** RMS, at rated speed for all loads through 110 percent of rated speed. The engine-generator set must be provided with vibration isolation in accordance with the manufacturer's standard recommendation. Where the vibration isolation system does not secure the base to the structure floor or unit foundation, provide seismic restraints in accordance with the seismic parameters specified.

1.4.3 Torsional Analysis

Submit torsional analysis including prototype testing or calculations which certify and demonstrate that no damaging or dangerous torsional vibrations will occur when the prime mover is connected to the generator, at synchronous speeds, plus/minus 10 percent.

1.4.4 Performance Data

Submit vibration isolation system performance data for the range of frequencies generated by the engine-generator set during operation from no load to full load and the maximum vibration transmitted to the floor. Also submit a description of seismic qualification of the engine-generator mounting, base, and vibration isolation.

1.4.5 Experience

Each component manufacturer must have a minimum of 3 years' experience in the manufacture, assembly and sale of components used with stationary engine-generator sets for commercial and industrial use. The engine-generator set manufacturer/assembler must have a minimum of 3 years' experience in the manufacture, assembly and sale of stationary engine-generator sets for commercial and industrial use. Submit a statement showing and verifying these requirements.

1.4.6 Field Engineer

The engine-generator set manufacturer or assembler must furnish a qualified field engineer to supervise the complete installation of the engine-generator set, assist in the performance of the onsite tests, and instruct personnel as to the operational and maintenance features of the equipment. The field engineer must have attended the engine generator manufacturer's training courses on installation and operation and maintenance of engine generator sets. Submit a letter listing the qualifications, schools, formal training, and experience of the field engineer.

1.4.7 Detailed Drawings

Submit detailed drawings showing the following:

- a. Base-mounted equipment, complete with base and attachments, including anchor bolt template and recommended clearances for maintenance and operation.
- b. Starting system.
- c. Fuel system.
- d. Cooling system.
- e. Exhaust system.
- f. Electric wiring of relays, breakers, programmable controllers, and switches including single line and wiring diagrams.
- g. Lubrication system, including piping, pumps, strainers, filters, electric heater, controls and wiring.
- h. Location, type, and description of vibration isolation devices for all applications.
- i. The safety system, including wiring schematics.
- j. One-line schematic and wiring diagrams of the generator, exciter, regulator, governor, and instrumentation.
- k. Panel layouts.
- l. Mounting and support for each panel and major piece of electrical equipment.
- m. Engine-generator set rigging points and lifting instructions.

1.4.8 **Auxiliary Systems** Engine-Generator Set and Auxiliary Equipment
Drawing Requirements

Submit drawings pertaining to the engine-generator set and auxiliary equipment, including but not limited to the following:

- a. Certified outline, general arrangement (setting plan), and anchor bolt details. Show total weight and center of gravity of assembled equipment on the steel sub-base.
- b. Detailed elementary, schematic wiring, and interconnection diagrams of the engine starting system, jacket coolant heating system, engine protective devices, engine alarm devices, engine speed governor system, generator and excitation system, and other integral devices.
- c. Detailed elementary, schematic wiring; and interconnection diagrams of the fuel system, starting battery system, engine-generator control panel, generator circuit breaker, and remote alarm annunciator.
- d. Dimensional drawings or catalog cuts of exhaust silencers, radiator, fuel day tanks, fuel oil cooler, valves and pumps, intake filters, vibration isolators, and other auxiliary equipment not integral with the engine-generator set.

1.4.9 Auxiliary Systems Drawing Requirements

Submit drawings showing floor plan arrangement of exhaust, air intake, and jacket coolant water systems including arrangement of piping and pipe sizes.

1.4.10 Vibration Isolation System Certification

Submit certification from the manufacturer that the vibration isolation system will reduce the vibration to the limits specified in the paragraph VIBRATION ISOLATION.

1.4.11 Fuel System Certification

When the fuel system requires a fuel oil cooler as described in the paragraph FUEL OIL COOLER, submit certification from the engine manufacturer that the fuel system design is satisfactory.

1.5 DELIVERY, STORAGE, AND HANDLING

Properly protect materials and equipment, in accordance with the manufacturers recommended storage procedures, before, during, and after installation. Protect stored items from the weather and contamination. During installation, cap piping and similar openings to keep out dirt and other foreign matter.

Deliver equipment on pallets or blocking wrapped in heavy-duty plastic, sealed to protect parts and assemblies from moisture and dirt. Protect and prepare batteries for shipment as recommended by the battery manufacturer. Store auxiliary equipment at the site in covered enclosures, protected from atmospheric moisture, dirt, and ground water.

1.6 EXTRA MATERIALS

Provide two sets of special tools and two sets of filters required for maintenance. Special tools are those that only the manufacturer provides, for special purposes, or to reach otherwise inaccessible parts. One handset must be provided for each electronic governor when required to indicate and/or change governor response settings. Furnish 4 liters one gallon of identical paint used on engine-generator set in manufacturer's sealed container with each engine-generator set.

Wrenches and tools specifically designed and required to work on the new equipment, which are not commercially available as standard mechanic's tools, must be furnished to the Contracting Officer.

Provide proposed operating instructions for the engine-generator set and auxiliary equipment laminated between matte-surface thermoplastic sheets and suitable for placement adjacent to corresponding equipment. After approval, install operating instructions where directed.

1.7 MAINTENANCE SERVICES

Submit the operation and maintenance manuals and have them approved prior to commencing onsite tests.

1.7.1 Operation Manual

Provide three copies of the operation manual in 8-1/2 by 11 inch

three-ring binders. Sections must be separated by heavy plastic dividers with tabs which identify the material in the section. Fold drawings with the title block visible, and placed in 8-1/2 by 11 inch plastic pockets with reinforced holes. The manual must include:

- a. Step-by-step procedures for system startup, operation, and shutdown;
- b. Drawings, diagrams, and single-line schematics to illustrate and define the electrical, mechanical, and hydraulic systems with their controls, alarms, and safety systems;
- c. Procedures for interface and interaction with related systems to include automatic transfer switches.

1.7.2 Maintenance Manual

Provide three copies of the maintenance manual containing the information described below in 8-1/2 x 11 inch three-ring binders. Separate each section by a heavy plastic divider with tabs. Fold drawings with the title block visible, and placed in plastic pockets with reinforced holes. The manual must include:

- a. Procedures for each routine maintenance item.
- b. The manufacturer's recommended maintenance schedule.
- c. A component list which includes the manufacturer's name, address, type or style, model or serial number, rating, and catalog number for the major components.
- d. A list of spare parts for each piece of equipment and a complete list of materials and supplies needed for operation.

1.7.3 Assembled Operation and Maintenance Manuals

The contents of the assembled operation and maintenance manuals must include the manufacturer's O&M information required by the paragraph SD-10, OPERATION AND MAINTENANCE DATA and the manufacturer's O&M information.

- a. Manuals must be in separate books or volumes, assembled and bound securely in durable, hard covered, water resistant binder, and indexed by major assembly and components in sequential order.
- b. A table of contents (index) must be made part of the assembled O&M. The manual must be assembled in the order noted in table of contents.
- c. The cover sheet or binder on each volume of the manuals must be identified and marked with the words, "Operation and Maintenance Manual."

1.8 SITE CONDITIONS

Protect the components of the engine-generator set, including cooling system components, pumps, fans, and similar auxiliaries when not operating and provide components capable of the specified outputs in the following environment:

- a. Site Location: **Maxwell AFB, Montgomery, AL**
- b. Site Elevation: **200 feet** above mean sea level.
- c. Ambient Temperatures:
 - (1) Maximum **98 degrees F** dry bulb.
 - (2) Minimum **26 degrees F** dry bulb.
- d. Design Wind Velocity: **10 mph**.
- e. Prevailing Wind Direction: **From the south**
- f. Seismic Zone: Zone **1** as defined by **ICC IBC**.

PART 2 PRODUCTS

2.1 SYSTEM REQUIREMENTS

- a. Provide and install each engine-generator set complete and totally functional, with all necessary ancillary equipment to include: air filtration; starting system; generator controls, protection, and isolation; instrumentation; lubrication; fuel system; cooling system; and engine exhaust system. Each engine-generator set must satisfy the requirements specified in the Engine-Generator Parameter Schedule. Submit certification that the engine-generator set and cooling system function properly in the ambient temperatures specified.
- b. Provide each engine-generator set consisting of one engine, one generator, and one exciter mounted, assembled, and aligned on one base; and all other necessary ancillary equipment which may be mounted separately. Assemble sets having a capacity of 750 kW or smaller and attach to the base prior to shipping. Sets over 750 kW capacity may be shipped in sections. Provide set components that are environmentally suitable for the locations shown and that are the manufacturer's standard product offered in catalogs for commercial or industrial use. Provide a generator strip heater for moisture control when the generator is not operating. Identify any nonstandard products or components and the reason for their use.

2.1.1 Engine-Generator Parameter Schedule

Engine-Generator Set and Auxiliary Equipment Capacity Calculations for Engine-Generator Set

ENGINE-GENERATOR PARAMETER SCHEDULE	
Identification	Make/Model
Electrical Characteristics	
Power Rating	Emergency Standby Gross bhp rating / Net brake power rating As indicated by size selection kW at 0.8 power factor

ENGINE-GENERATOR PARAMETER SCHEDULE	
Governor Type	Type Make / Model Isochronous
Overload Capacity (Prime applications only)	110 percent of Service Load for 1 hour in 12 consecutive hours
Service Load	As shown on drawings. kVA (maximum) As shown on drawings kVA (continuous)
Motor Starting kVA (Max.)	As shown on drawings. kVA
Power Factor	0.8 lagging
Engine-Generator Applications	stand-alone
Voltage Regulation (No Load to Full Load)(Stand-alone applications)	plus or minus 2 percent (maximum)
Voltage Bandwidth (steady state)	plus or minus 0.5 percent
Frequency	60 Hz
Voltage	As shown on drawings volts
Phases	As shown on drawings.
Minimum Generator Sub-transient Reactance	Varies percent Sub-transient
Nonlinear Loads	Varies kVA
Max Step Load Increase	100 percent of Service Load at .8 PF
Transient Recovery Time with Step Load Increase (Voltage)	5 seconds
Transient Recovery	3 seconds
Time with Step Load Increase (Frequency)	
Maximum Voltage Deviation with Step Load Increase	10 percent of rated voltage
Maximum Frequency Deviation with Step Load Increase	2.5 percent of rated frequency
Max Step Load Decrease (without shutdown)	100 percent of Service Load at .8 PF

ENGINE-GENERATOR PARAMETER SCHEDULE	
Frequency Bandwidth (steady state)	plus or minus 0.4 percent
Frequency Regulation (droop) (No Load to Full Load)	3 percent (maximum)
Frequency Bandwidth (steady state)	plus or minus 0.4 percent
Reactances	Synchronous reactance, Xd Transient reactance, X'd Sub-transient reactance, X''d Negative sequence reactance, X2 Zero sequence reactance, Xo
Capacity Calculations	
Calculations must verify that the engine-generator set power rating is adequate for the following load conditions:	
Existing Maximum Demand	Bldg 941 302kw (June 2022), Bldg 804 467 kw (July 2022), Bldg 1016 and 1017 replace in kind with 20kw.K kw
Capacity Calculations for Batteries	
Calculation must verify that the engine starting battery capacity exceeds dc power requirements.	
Mechanical Characteristics	
Engine Description	Strokes/cycle Number of cylinders Bore and Stroke, inches
Engine Speed	1800 rpm
Heat Exchanger Type	fin-tube (radiator)
Engine Cooling Type	water/ethylene glycol
Intercooler Type	Air-to-Air / Jacket Water
Induction Method	Naturally Aspirated / Turbocharged
Turbocharger	Make / Model
Max Time to Start and be Ready to Assume Load	10 seconds

ENGINE-GENERATOR PARAMETER SCHEDULE	
Max Summer Indoor Temp (Prior to Engine-generator Operation)	97 degrees F
Min Winter Indoor Temp (Prior to Engine-generator Operation)	28 degrees F
Max Allowable Heat Transferred To Engine Generator Space at Rated Output Capacity	Varies MBTU/hr
Max Summer Outdoor Temp (Ambient)	97 degrees F
Min Winter Outdoor Temp (Ambient)	28 degrees F
Installation Elevation	200 above sea level
Engine-Generator Set Efficiencies	
Fuel Consumption	At 0.8 power factor, Gallons / hour for: 1 / 2 load 3 / 4 load Full Load
Generator Efficiency	At 0.8 power factor, (per cent) in accordance with IEC 60034-2A for: 1 / 2 load 3 / 4 load Full Load
Radiator Capacity	Coolant Type gpm coolant cfm air through radiator Btu per hr of heat exchange based on optimum coolant temperature to and from engine
Engine-Generator Set Emissions Data	
Exhaust Temperature	Degrees F at full load
Weight of Exhaust Gas	lb per hr at full load
Weight of Intake Air	lb per hr at full load
Total Heat Rejected	Btu per hr, at full load to: Jacket Coolant System Fuel Oil Cooling System

ENGINE-GENERATOR PARAMETER SCHEDULE	
Emissions	lb per hr, at full load Total Suspended Particulate Particulate Matter with an average aerodynamic diameter of 10 microns Sulfur Dioxides Nitrogen Oxides (as NO₂) Carbon Monoxide Volatile Organic Compounds
Visible Emissions	Percent opacity at full load
Brake Mean Effective Pressure (BMEP) Calculations	
Calculation must verify that the engine meets the specified maximum BMEP, as follows: $\text{BMEP psi} = \frac{(120,000 \times \text{bkw}) \times (792,000 \times \text{bhp})}{(\text{rpm} \times \text{cu. in.})}$ Where: bkw bhp = bkw' + bkw" bhp' + bhp" bkw" bhp" is the Brake kW horsepower required by engine driven fan for cooling radiator or motor driven fan for cooling radiator. bkw' bhp' = kW/GEN.EFF. kW/(GEN.EFF. times 0.746) GEN.EFF. = Generator efficiency cu. in. = Total engine piston displacement in cubic inches rpm = Engine revolutions per minute kW = Minimum power rating	
Torsional Vibration Stress Analysis Computations	

ENGINE-GENERATOR PARAMETER SCHEDULE
Torsional vibrational stresses in the crankshaft and generator shaft of assembled engine and driven generator must not exceed 5000 psi when engine is driving generator at rated speed while assembled unit is loaded to rated engine-generator set power. Computations must be based on a mathematical model of the assembled generator set provided or based on calculations using measured values from tests on a unit identical to the one provided. Calculations based on models of, or measured data from, the unassembled engine and generator will not be acceptable. Calculations must include: a. A description of the system relating information pertinent to analysis such as operating speed range and identification plate data. b. A mass elastic assembly drawing, showing the arrangement of the units in the generator set and dimensions of shafting, including minimum diameters (or section moduli) of shafting in the system. c. A labeled line diagram of the mass elastic system indicating values of masses, stiffness, equivalent lengths, and equivalent diameters including basic assumptions and definition of terms. d. Sample computations showing procedures used to obtain resulting stress values. e. Computations indicating assembled engine-generator speed of 1800 rpm with assembly loaded to rated generator power and the resulting computed critical torsional stress values in the assembled engine crankshaft and generator shaft.
Turbocharger Load Calculations
NOTE: When the engine-generator set installation includes field installed exhaust system (i.e., the engine-generator set is installed internal to a building in lieu of in a self-contained outdoor enclosure), include the following paragraph. When the proposed exhaust system layout is different from that shown on the contract drawings, submit calculations showing that the external loads from the exhaust system such as weight and thermal expansion do not exceed the engine manufacturer's maximum allowed forces and moments on the turbocharger.

2.1.2 Rated Output Capacity

Provide each engine-generator-set with power equal to the sum of service load plus the machine's efficiency loss and associated ancillary equipment loads. Rated output capacity must also consider engine and/or generator oversizing required to meet requirements in paragraph Engine-Generator Parameter Schedule.

The engine must meet the specified maximum BMEP requirements at rated speed as calculated in accordance with the calculations in the engine-generator parameter schedule. The engine capacity must be based on

the following:

- a. Engine burning diesel fuel conforming to MIL-DTL-16884 at an ambient temperature of 85 degrees F. For stationary engines operated in the United States, diesel fuel requirements are found in 40 CFR 60 Subpart IIII.
- b. Engine cooled by a radiator fan mechanically driven by the engine or remote with a motor driven fan.
- c. Engine cooled by coolant mixture of water and ethylene glycol, 50 percent by volume of each.

2.1.2.1 Engine Emission Limits

Engine must be certified by the manufacturer to meet applicable EPA emission standards found in 40 CFR 60 Subpart IIII. In addition, engine must meet any applicable state or local emission requirements (ex: California SCAQMD).

2.1.2.2 Performance Class

The voltage and frequency behavior of the generator set must be in accordance with ISO 8528 operating limit values for performance Class G2 .

2.1.3 Power Ratings

Power ratings must be in accordance with EGSA 101P.

2.1.4 Transient Response

The engine-generator set governor and voltage regulator must cause the engine-generator set to respond to the maximum step load changes such that output voltage and frequency recover to and stabilize within the operational bandwidth within the transient recovery time. The engine-generator set must respond to maximum step load changes such that the maximum voltage and frequency deviations from bandwidth are not exceeded.

2.1.5 Reliability and Durability

Each standby engine-generator set must have both an engine and a generator capable of delivering the specified power on a standby basis with an anticipated mean time between overhauls of no less than 5,000 hours operating with a load factor of 70 percent. Cite two like engines and two like generators that have performed satisfactorily in a stationary power plant, independent and separate from the physical location of the manufacturer's and assembler's facilities, for standby without any failure to start, including all periodic exercise. Provide like engines and generators that have had no failures resulting in downtime for repairs in excess of 72 hours during two consecutive years of service. Provide engines that are the same model, speed, bore, stroke, number and configuration of cylinders, and rated output capacity. Provide generators that are the same model, speed, pitch, cooling, exciter, voltage regulator and rated output capacity.

Submit a reliability and durability certification letter from the manufacturer and assembler to prove that existing facilities are and have

been successfully utilizing the same components proposed to meet this specification, in similar service. Certification may be based on components, i.e. engines used with different models of generators and generators used with different engines, and does not exclude annual technological improvements made by a manufacturer in the basic standard-model component on which experience was obtained, provided parts interchangeability has not been substantially affected and the current standard model meets the performance requirements specified. Provide a list with the name of the installations, completion dates, and name and telephone number of a point of contact.

2.1.6 Engine-Generator Set Enclosure

Provide engine-generator set enclosures that are corrosion resistant and fully weather resistant. The enclosure must contain all set components and provide ventilation to permit operation at Service Load under secured conditions. Provide access doors to controls and equipment requiring periodic maintenance or adjustment. Provide removable panels for access to components requiring periodic replacement. The enclosure must be capable of being removed without disassembly of the engine-generator set or removal of components other than the exhaust system. The enclosure must reduce the noise of the generator set to within the limits specified in the paragraph SOUND LIMITATIONS.

2.1.7 Vibration Isolation

Provide an engine-generator set with a vibration isolation system in accordance with the manufacturer's standard recommendation. Submit vibration isolation system performance data for the range of frequencies generated by the engine-generator set during operation from no load to full load and the maximum vibration transmitted to the floor plus description of seismic qualification of the engine-generator mounting, base, and vibration isolation. Submit torsional analysis including prototype testing or and calculations which certify and demonstrate that no damaging or dangerous torsional vibrations will occur when the prime mover is connected to the generator, at synchronous speeds, plus 10 percent. Design and qualify vibration isolation systems as an integral part of the base and mounting system in accordance with the seismic parameters specified. Where the vibration isolation system does not secure the base to the structure floor or unit foundation, provide seismic restraints in accordance with the seismic parameters specified.

2.1.8 Harmonic Requirements

Non-linear loads to be served by each engine-generator set are as indicated. The maximum linear load demand (kVA at PF) when non-linear loads will also be in use is as indicated.

2.1.9 Starting Time Requirements

Upon receipt of a signal to start, each engine generator set will start, reach rated frequency and voltage and be ready to assume load within the time specified. For standby sets used in emergency power applications, each engine generator set will start, reach rated frequency and voltage, and power will be supplied to the load terminals of the automatic transfer switch within the starting time specified.

2.2 NAMEPLATES

Provide the manufacturer's name, type or style, model or serial number and rating on a plate secured to the equipment for each major component of this specification. Provide plates and tags sized so that inscription is readily legible to operating or maintenance personnel and securely mounted to or attached in proximity of their identified controls or equipment. Lettering must be normal block lettering, a minimum of 0.25 inch high. As a minimum, provide nameplates for:

Engines

Generators

Transformers (CT & PT)

Regulators

Pumps and pump motors

Governors

Generator Breaker

Economizers

Where the following equipment is not provided as a standard component by the engine generator set manufacturer, the nameplate information may be provided in the maintenance manual in lieu of nameplates.

Battery charger

Heaters

Switchboards

Exhaust mufflers

Switchgear

Silencers

Battery

Exciters

2.2.1 Materials

Construct ID plates and tags of 16 gage minimum thickness bronze or stainless steel sheet metal engraved or stamped with inscription. Construct plates and tags not exposed to the weather or high operational temperature of the engine of laminated plastic, 0.125 inch thick, matte white finish with black center core, with lettering accurately aligned and engraved into the core.

2.2.2 Control Devices and Operation Indicators

Provide ID plates or tags for control devices and operation indicators, including valves, off-on switches, visual alarm annunciators, gages and thermometers, that are required for operation and maintenance of provided mechanical systems. Plates or tags must be minimum of 0.5 inch high and 2 inches long and must indicate component system and component function.

2.2.3 Equipment

Provide ID plates of a minimum size of high and 5 inches long on provided equipment indicating the following information:

- a. Manufacturer's name, address, type and model number, serial number, and certificate of compliance with applicable EPA mission standards;
- b. Contract number and accepted date;
- c. Capacity or size;
- d. System in which installed; and
- e. System which it controls.

2.3 SAFETY DEVICES

Exposed moving parts, parts that produce high operating temperatures, parts which may be electrically energized, and parts that may be a hazard to operating personnel must be insulated, fully enclosed, guarded, or fitted with other types of safety devices. Install safety devices such that proper operation of the equipment is not impaired.

2.4 MATERIALS AND EQUIPMENT

Submit certification stating that where materials or equipment are specified to comply with requirements of UL, written proof of such compliance has been obtained. The label or listing of the specified agency, or a written certificate from an approved, nationally recognized testing organization equipped to perform such services, stating that the items have been tested and conform to the requirements and testing methods of the specified agency are acceptable as proof.

2.4.1 Circuit Breakers, Low Voltage

UL 489.

2.4.2 Filter Elements

Provide the manufacturer's standard fuel-oil, lubricating-oil, and combustion-air filter elements.

2.4.3 Instrument Transformers

NEMA/ANSI C12.11.

2.4.4 Pipe (Fuel/Lube-Oil, Compressed Air, Coolant, and Exhaust)

ASTM A53/A53M, or ASTM A106/A106M steel pipe. Pipe smaller than 2 inches must be Schedule 80. Pipe 2 inches and larger must be Schedule 40.

2.4.4.1 Flanges and Flanged Fittings

ASTM A181/A181M, Class 60, or ASME B16.5, Grade 1, Class 150.

2.4.4.2 Pipe Welding Fittings

ASTM A234/A234M, Grade WPB or WPC, Class 150 or ASME B16.11, 3000 lb.

2.4.4.3 Threaded Fittings

ASME B16.3, Class 150.

2.4.4.4 Valves

MSS SP-80, Class 150.

2.4.4.5 Gaskets

Manufacturer's standard.

2.4.5 Pipe Hangers

MSS SP-58.

2.4.6 Electrical Enclosures

NEMA ICS 6.

2.4.6.1 Switchboards

NEMA PB 2.

2.4.6.2 Panelboards

NEMA PB 1.

2.4.7 Electric Motors

Provide electric motors that conform to the requirements of NEMA MG 1. Motors must have sealed ball bearings and a maximum speed of 1800 rpm. Motors used indoors must have drip-proof frames; enclose those that are used outside. Alternating current motors larger than 1/2 Hp must be of the squirrel-cage induction type for operation on 208 volts or higher, 60 Hz, and three-phase power. Alternating current motors 1/2 Hp or smaller, must be suitable for operation on 120 volts, 60 Hz, and single-phase power. Direct current motors must be suitable for operation on 125 volts.

2.4.8 Motor Controllers

Provide motor controllers and starters that conform to the requirements of NFPA 70 and NEMA ICS 2.

2.5 ENGINE

Each engine must operate on No. 2-D diesel fuel conforming to ASTM D975, must be designed for stationary applications and must be complete with ancillaries. The engine must be a standard production model shown in the manufacturer's catalog describing and depicting each engine-generator set and all ancillary equipment in sufficient detail to demonstrate complete specification compliance. The engine must be naturally aspirated, supercharged, or turbocharged. The engine must be 2- or 4-stroke-cycle and compression-ignition type. The engine must be vertical in-line, V- or opposed-piston type, with a solid cast block or individually cast cylinders. The engine must have a minimum of two cylinders. Opposed-piston type engines must have more than four cylinders. Each block must have a coolant drain port. Equip each engine with an over-speed sensor.

ISO 3046. Diesel engines must be four-cycle naturally aspirated, or turbocharged, or turbocharged and intercooled; vertical in-line or vertical Vee type; designed for stationary service. Engines must be

capable of immediate acceleration from rest to normal speed without intermediate idle/warm up period or pre-lubrication to provide essential electrical power. Two-cycle engines are not acceptable.

2.5.1 Sub-base Mounting

Mount each engine-generator set on a structural steel sub-base sized to support the engine, generator, and necessary accessories, auxiliaries and control equipment to produce a complete self-contained unit as standard with the manufacturer. Design the structural sub-base to properly support the equipment and maintain proper alignment of the engine-generator set in the specified seismic zone. In addition, provide sub-base with both lifting rings and jacking pads properly located to facilitate shipping and installation of the unit. Factory align engine and generator on the sub-base and securely bolt into place in accordance with the manufacturer's standard practice. Crankshaft must have rigid coupling for connection to the generator.

2.5.2 Assembly

Completely shop assemble each engine-generator set on its structural steel sub-base. Paint entire unit with manufacturer's standard paints and colors. After factory tests and before shipping, thoroughly clean and retouch painting as necessary to provide complete protection.

2.5.3 Turbocharger

If required by the manufacturer to meet the engine-generator set rating, provide turbine type driven by exhaust gas from engine cylinders, and direct connected to the blower supplying air to the engine intake manifold.

2.5.4 Crankcase Protection

2.5.5 Miscellaneous Engine Accessories

Provide the following engine accessories where the manufacturer's standard design permits:

- a. Piping on engine to inlet and outlet connections, including nonstandard companion flanges.
- b. Structural steel sub-base and vibration isolators, foundation bolts, nuts, and pipe sleeves.
- c. Level jack screws or shims, as required.
- d. Rails, chocks, and shims for installation of sub-base on the foundation.
- e. Removable guard, around fan. Support guard, on engine sub-base, to suit manufacturer's standard.

2.6 FUEL SYSTEM

Provide fuel system conforming to the requirements of NFPA 30 and NFPA 37 and containing the following elements.

2.6.1 Pumps

2.6.1.1 Main Pump

Provide engines with an engine driven pump. The pump must supply fuel at a minimum rate sufficient to provide the amount of fuel required to meet the performance indicated within the parameter schedule. Base the fuel flow rate on meeting the load requirements and all necessary recirculation.

2.6.1.2 Auxiliary Fuel Pump

Provide auxiliary fuel pumps to maintain the required engine fuel pressure, if either required by the installation or indicated on the drawings. The auxiliary pump must be driven by a dc electric motor powered by the starting/station batteries. Automatically actuate the auxiliary pump by a pressure-detecting device.

2.6.2 Fuel Filter

Provide a minimum of one full-flow fuel filter for each engine. The filter must be readily accessible and capable of being changed without disconnecting the piping or disturbing other components. Mark the inlet and outlet connections of the filter.

Provide intake filter assemblies for each engine of the oil bath or dry type, as standard with the manufacturer. Filters must be capable of removing a minimum of 92 percent of dirt and abrasive 3 microns and larger from intake air. Size filters to suit engine requirements at 100 percent of rated full load. Design unit for field access for maintenance purposes.

2.6.3 Relief/Bypass Valve

Provide a relief/bypass valve to regulate pressure in the fuel supply line, return excess fuel to a return line and prevent the build-up of excessive pressure in the fuel system.

2.6.4 Integral Main Fuel Storage Tank

Provide each engine with an integral main fuel tank. Each tank must be factory installed and provided as an integral part of the generator manufacturer's product. Provide each tank with connections for fuel supply line, fuel return line, local fuel fill port, gauge, vent line, and float switch assembly. Provide a fuel return line cooler as recommended by the manufacturer and assembler. The temperature of the fuel returning to the tank must be below the flash point of the fuel. Mount the tank within the enclosure for each engine-generator set provided with weatherproof enclosures. The fuel fill line must be accessible without opening the enclosure.

- a. All Tanks: **UL 142**. Provide integral in skid **or** free standing double wall **as shown on drawings** (110 percent containment) fuel tanks with a minimum capacity of **72** hours of engine-generator set operation at full-rated load. Epoxy coat day tanks inside and prime and paint outside. Construct tanks of not less than **3/16 inch** steel plate with welded joints and necessary stiffeners on exterior of tank. Provide a braced structural steel framework support. Weld tank top tight. Provide **4 1/2 inch** square inspection port with a 2 inch NPT fill connection and spill box. Provide proper normal and emergency venting for the primary tank and emergency venting only for the secondary tank

- / containment basin in accordance with [UL 142](#) requirements. Provide an overflow or return line between the fuel tank and storage tank in accordance with [NFPA 37](#).
- b. Float Switches for Tanks: Provide tank-top mounted or external float cage, single-pole, single-throw type designed for use on fuel oil tanks. Arrange high level float switches to close on rise of liquid level, and low level float switches to close on fall of liquid level. Mount float cage units with isolating and drain valves. Contacts must be suitable for the station battery voltage.
 - (1) Critical low level float switch which must activate at 5 percent of normal liquid level must shut engine off.
 - (2) Low-low level float switch which must activate alarm at 30 percent of normal liquid level.
 - (3) Critical high level float switch which must activate alarm at 95 percent of normal liquid level.
 - c. Leak Detector Switch for All Tanks: Actuates when fuel is detected in containment basin, stops fuel transfer pump, and closes the fuel oil solenoid valve.
 - d. Control Panel for All Tanks: Provide [NEMA ICS 6](#), Type 1, enclosed control panel for each day tank. Control panel must include the following accessories.
 - (1) Power available LED (green).
 - (2) Critical low fuel alarm contacts for shut down of engine.
 - (3) Low-low level fuel alarm LED.
 - (4) Low-low level fuel alarm contracts for remote annunciator.
 - (5) Critical high level fuel alarm LED.
 - (6) Leak detecting alarm LED.
 - (7) Alarm horn.
 - e. Tank Gages for All Tanks: Provide buoyant force type gages for fuel tanks with dial indicator not less than [4 inches](#) in size and arranged for top mounting. Calibrate each reading dial or scale for its specific tank to read from empty to full, with intermediate points of 1/4, 1/2, and 3/4.
 - f. Integral Base Tanks Used as Primary Tank: Provide a 2 inch opening at the tank fill port, fitted an overfill prevention valve (OPV). Additionally, the fill opening must be perpendicular to the tank in order to allow operation of the OPV. Integral base tank must be sized and configured such that the filling and venting nozzles are outside the generator cabinet for ease of accessibility, inspection, and maintenance. Level gage must be in the line of sight from the fill port.
 - g. External tanks (all non-integral base tanks)

2.6.4.1 Capacity

Each tank must have capacity as shown to supply fuel to the engine for an uninterrupted 72 period at 100 percent rated load without being refilled.

2.6.4.2 Local Fuel Fill

Each local fuel fill port on the day tank must have a screw-on cap.

2.6.4.3 Fuel Level Controls

Provide tanks with a float-switch assembly to perform the following functions:

- a. Activate the "Low Fuel Level" alarm at 70 percent of the rated tank capacity.
- b. Activate the "Overfill Fuel Level" alarm at 95 percent of the rated tank capacity.

2.6.4.4 Arrangement

Integral tanks may allow gravity flow into the engine. Gravity flow tanks and any tank that allows a fuel level above the fuel injectors must have an internal or external factory installed valve located as near as possible to the shell of the tank. The valve must close when the engine is not operating. Provide integral day tanks with any necessary pumps to supply fuel to the engine as recommended by the generator set manufacturer. The fuel supply line from the tank to the manufacturer's standard engine connection must be welded pipe.

2.6.5 Strainer

2.6.6 Fuel Oil Meters

2.6.7 Fuel Oil Cooler

Provide an air cooled fuel oil cooler if the temperature of the fuel returned to the tank from the engine will cause overheating of the tank fuel above the maximum fuel temperature allowed by the engine manufacturer when operating at maximum rated generator power output and low fuel level in the tank. The fuel oil cooler must be furnished by the engine manufacturer for the application and the installation must be complete including piping and power requirements.

2.7 LUBRICATION

Provide engine with a separate lube-oil system conforming to NFPA 30 and NFPA 37. Pressurize each system by engine-driven pumps. Regulate system pressure as recommended by the engine manufacturer. Provide a pressure relief valve on the crankcase for closed systems. Vent the crankcase in accordance with the manufacturer's recommendation. Do not vent the

crankcase to the engine exhaust system. Crankcase breathers, if provided on engines installed in buildings or enclosures, must be piped to vent to the outside. The system must be readily accessible for service such as draining, refilling, etc. Each system must permit addition of oil and have oil-level indication with the set operating. The system must utilize an oil cooler as recommended by the engine manufacturer.

2.7.1 Lube-Oil Filter

Provide one full-flow filter for each pump. The filter must be readily accessible and capable of being changed without disconnecting the piping or disturbing other components. Mark inlet and outlet connections.

2.7.2 Lube-Oil Sensors

Equip each engine with lube-oil pressure sensors located downstream of the filters and provide signals for required indication and alarms. Submit two complete sets of filters, required for maintenance, supplied in a suitable storage box. Provide these filters in addition to filters replaced after testing.

2.7.3 Precirculation Pump

Provide a motor-driven precirculation pump powered by the station battery, complete with motor starter, if recommended by the engine manufacturer.

2.8 COOLING SYSTEM

Provide each engine with its own cooling system to operate automatically while its engine is running. The cooling system coolant must use a combination of water and ethylene-glycol sufficient for freeze protection at the minimum winter outdoor temperature specified. The maximum temperature rise of the coolant across each engine must not exceed that recommended below. Submit a letter which certifies that the engine-generator set and cooling system function properly in the ambient temperature specified, stating the following values:

- a. The maximum allowable inlet temperature of the coolant fluid shall be the maximum allowed by the manufacturers specifications.
- b. The minimum allowable inlet temperature of the coolant fluid through the engine shall be the minimum allowed by the manufacturers specifications.
- c. The maximum allowable temperature rise in the coolant fluid through the engine shall be the maximum allowed by the manufacturers specifications.
- d. The minimum allowable inlet fuel temperature.

2.8.1 Coolant Pumps

Provide centrifugal coolant pumps. Each engine must have an engine-driven primary pump. Provide secondary pumps that are electric motor driven and have automatic controllers. Control raw-water circulating pump by manual-off-automatic controllers and must be engine driven.

2.8.2 Heat Exchanger

Provide heat exchanger with the size and capacity to limit the maximum allowable temperature rise in the coolant across the engine to that recommended and submitted for the maximum summer outdoor design temperature and site elevation. Submit manufacturer's data to quantify heat rejected to the space with the engine generator set at rated capacity. Provide heat exchangers that are corrosion resistant, suitable for service in ambient conditions of application.

2.8.2.1 Fin-Tube-Type Heat Exchanger (Radiator)

Heat exchanger may be factory coated with corrosion resistant film, provided that corrective measures are taken to restore the heat rejection capability of the radiator to the initial design requirement via oversizing, or other compensating methods. Provide internal surfaces that are compatible with liquid fluid coolant used. Materials and coolant are subject to approval by the Contracting Officer. Provide heat exchangers that are pressure type incorporating a pressure valve, vacuum valve and a cap. Design caps for pressure relief prior to removal. Provide heat exchanger and cooling system that is capable of withstanding a minimum pressure of 7 psi and protect with a strong grille or screen guard. Provide heat exchanger with at least two tapped holes; equip one tapped hole with a drain cock, and plug the rest.

Provide for each engine-generator set, as standard with the manufacturer.

- a. Design Conditions: Each radiator unit must have ample capacity to remove not less than the total Btu per hour of heat rejected by its respective engine at 100 percent full-rated load to the jacket water, fuel oil, and lubricating oil system, and intercooler. Radiator capacity must be rated at optimum temperature of coolant leaving the engine and intercooler as recommended by the engine manufacturer with an ambient dry bulb air temperature outside the enclosure of 97 degrees F maximum, and 28 degrees F minimum at the site elevation specified in the paragraph SITE CONDITIONS, and with the coolant mixture specified in the paragraph ENGINE CAPACITY. Pressure drop through the radiator must not exceed 6 psi when circulating the maximum required coolant flow. Radiator air velocity must be a maximum of 1500 feet per minute.
- b. Engine Mounted Radiator Construction: Radiator fan must direct airflow from the engine outward through the radiator. Fan must be V-belt driven directly from the engine crankshaft. Radiator fan must have sufficient capacity to meet design conditions against a static restriction of 36 inch of water. Fan static capacity must be adjusted to suit the ductwork furnished. Cooling section must have a tube and fin-type core consisting of copper or copper base alloy tubes with nonferrous fins. Select engine-driven fans for quiet vibration-free operation. Make provision for coolant expansion either by self-contained expansion tanks or separately mounted expansion tanks, as standard with the manufacturer. Provide suitable guards for each fan and drive.
- c. Remote Radiator Construction: Provide radiators as described above, except radiators must be remotely piped and provided with electric motor driven fan. Drive must be multiple V-belt or reduction gears. Expansion tanks must be separately mounted. Air flow must be vertical or horizontal as indicated. Interlock fan with engine operation such

that fan must operate when engine operates when recommended by engine manufacturer. Provide controls and control devices complete which must cycle fan on and off based upon coolant temperature. Provide motors and controllers in accordance with the paragraphs ELECTRIC MOTORS and MOTOR CONTROLLERS, respectively. Motors, controllers, contactors, and disconnects must conform to Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

- d. Coolant solution must be a mixture of clean water and ethylene glycol, 50 percent by volume each. Provide an anti-freeze solution tester suitable for the mixture.

2.8.3 Thermostatic Control Valve

Provide a modulating type, thermostatic control valve in the coolant system to maintain the coolant temperature range submitted in paragraph SUBMITTALS.

2.8.4 Ductwork

Provide ductwork as specified in Section Section 23 31 13.00 40 METAL DUCTS except use a flexible connection to connect the duct to the engine radiator. Material for the connection must be wire-reinforced glass. Provide airtight connection.

2.8.5 Temperature Sensors

Equip each engine with coolant temperature sensors. Provide temperature sensors with signals for pre-high and high indication and alarms.

2.9 SOUND LIMITATIONS

Submit sound power level data for the packaged unit operating at 100 percent load in a free field environment. The data should demonstrate compliance with the sound limitation requirements of this specification. Submit certification from the manufacturer stating that the sound emissions meet the specification. Do not exceed the following sound pressure levels in any of the indicated frequencies when measured in a free field at a radial distance of 22.9 feet 7 meters at 45 degrees apart in all directions when operating at 100 percent load.

Frequency Band (Hz)	Maximum Acceptable Sound Level (Decibels)
31	87
63	87
125	77
250	70
500	64
1,000	61

Frequency Band (Hz)	Maximum Acceptable Sound Level (Decibels)
2,000	60
4,000	60
8,000	62

2.10 AIR INTAKE EQUIPMENT

Locate filters and silencers in locations that are convenient for servicing. Provide high-frequency filter type silencers and locate in the air intake system as recommended by the engine manufacturer. Provide silencer to reduce the noise level at the air intake so that the indicated pressure levels specified in paragraph SOUND LIMITATIONS will not be exceeded. A combined filter-silencer unit meeting requirements for the separate filter and silencer items may be provided. Provide copper expansion elements in air-intake lines.

Provide intake filter assemblies for each engine of the oil bath or dry type, as standard with the manufacturer. Filters must be capable of removing a minimum of 92 percent of dirt and abrasive 3 microns and larger from intake air. Size filters to suit engine requirements at 100 percent of rated full load. Design unit for field access for maintenance purposes.

2.11 EXHAUST SYSTEM

Provide a separate and complete system for each engine. Support piping to minimize vibration. Where a V-type engine is provided, use a V-type connector, with necessary flexible sections and hardware, to connect the engine exhaust outlets.

2.11.1 Flexible Sections and Expansion Joints

Provide a flexible section at each engine and an expansion joint at each muffler. Provide flexible sections and expansion joints that have flanged connections. Provide flexible sections made of convoluted seamless tube without joints or packing. Provide bellows type expansion joints. Provide stainless steel expansion and flexible elements suitable for engine exhaust gas at the maximum exhaust temperature that is specified by the engine manufacturer. Provide expansion and flexible elements that are capable of absorbing vibration from the engine and compensation for thermal expansion and contraction.

2.11.2 Exhaust Muffler

Provide a chamber type exhaust muffler. Provide welded steel muffler designed for outdoor or indoor mounting as dictated by generator location. . Provide eyebolts, lugs, flanges, or other items as necessary for support in the location and position indicated. Do not exceed the engine manufacturer's recommended pressure drop. Outside mufflers must be zinc coated or painted with high temperature 400 degrees F resisting paint. The muffler and exhaust piping together must reduce the noise level to less than the maximum acceptable level listed for sound limitations in paragraph SOUND LIMITATIONS. Provide muffler with a drain valve, nipple, and cap at the low-point of the muffler.

A critical class silencer must be provided for each engine which will

reduce the exhaust sound spectrum by the following listed values at a 75 foot radius from the outlet, with generator set loaded to rated capacity and clear weather. Inlet and outlet connections must be flanged.

Octave Band Center Frequency (Hertz)								
Minimum Silencer Attenuation Decibels	63	125	250	500	1000	2000	4000	8000
Critical Class	15	32	37	36	30	36	37	37

2.11.3 Exhaust Piping

Slope horizontal sections of exhaust piping downward away from the engine to a drip leg for collection of condensate with drain valve and cap. Changes in direction must be long radius. Insulate exhaust piping, mufflers and silencers installed inside any building in accordance with paragraph THERMAL INSULATION and covered to protect personnel. Provide vertical exhaust piping with a hinged, gravity-operated, self-closing, rain cover.

Field installed exhaust piping must conform to the following:

- a. Exhaust Piping: Provide flanges for connections to engines, exhaust mufflers, and flexible connections. Provide steel pipe conforming to ASTM A53/A53M for each engine complete with necessary fittings, flanges, gaskets, bolts, and nuts. Exhaust piping must be Schedule 40 pipe for 12 inches and smaller, standard weight for sizes 14 inches through 24 inches, and 0.25 inch wall thickness for sizes larger than 24 inches. Flanges must be Class 150 slip-on forged steel welding flanges in accordance with ASME B16.5, with material in accordance with ASTM A181/A181M, Grade I. Fittings must be butt welding conforming to ASTM A234/A234M, with wall thickness same as adjoining piping. Fittings must be of same material and wall thickness as pipe. Built-up miter welded fittings may be used. Miter angles of each individual section must not exceed 22.5 degrees total and not more than 11.25 degrees relative to the axis of the pipe at any one cut. Gaskets for exhaust piping must be of high temperature asbestos-free material suitable for the service and must be ASME B16.21, composition ring, 0.0625 inch thick. Bolting material for exhaust flanges must be alloy-steel bolt-studs conforming to ASTM A193/A193M, Grade B7 bolts and alloy-steel nuts conforming to ASTM A194/A194M, Grade 7. Bolts must be of sufficient length to obtain full bearing on the nuts and must project not more than two full threads beyond the nut. Provide stainless steel counterbalance type rain caps at termination of each exhaust pipe.
- b. Expansion (Flexible) Joints: Provide sections of multiple corrugated stainless steel expansion joints in the engine exhaust piping for each engine to absorb expansion strains and vibration transmitted to the piping. Flexible joints must be suitable for operation at 200 degrees F above normal exhaust gas temperature at 100 percent load, 10,000 cycles, minimum. Joints must be flanged and located between engine exhaust manifold and exhaust piping, must be the same size as exhaust piping size, and must be designed and constructed for engine exhaust service.
- c. Hangers and Supports: MSS SP-58.

- d. Piping Sleeves: Provide where piping passes through masonry or concrete walls, floors, roofs, and partitions. Sleeves must be placed during construction. Unless indicated otherwise, pipe sleeves must comply with following requirements: sleeves in outside walls below and above grade, in floor, or in roof slabs, must be standard weight zinc coated steel pipe. Sleeves in partitions must be zinc coated sheet steel having a nominal weight of not less than **0.90 pound per square foot**. Space between piping insulation and the sleeve must not be less than **0.25 inch**. Sleeves must be held securely in proper position and location during construction. Sleeves must be sufficient length to pass through entire thickness of walls, partitions, or slabs. Sleeves in floor slabs must extend **2 inches** above the finished floor. Space between the pipe and the sleeve must be firmly packed with insulation and caulked at both ends of the sleeve with plastic waterproof cement.
- e. Piping Insulation: Provide exhaust piping insulation in accordance with Section **23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS**.

2.12 PYROMETER

Provide a pyrometer, and thermocouple with calibrated leads to show the temperature of the combined exhaust. For a supercharged engine, provide additional points, thermocouples and leads to show the temperature in the turbocharger exhaust gas outlet and combustion air discharge passages. Graduated scale length less than **6 inches** is not acceptable. Provide double pole selector switch with an "off" position, one set of points for each thermocouple, and suitable indicating dial. Calibrate the pyrometer, thermocouples, leads and compensating devices to show true exhaust temperature within plus or minus 1 percent above the highest temperature encountered at 110 percent load conditions.

2.13 EMISSIONS

The finished installation must comply with Federal, state, and local regulations and restrictions regarding the limits of emissions. Submit certification from the engine manufacturer stating that the engine exhaust emissions meet the federal, state, and local regulations and restrictions specified. At a minimum this certification must include emission factors for criteria pollutants including nitrogen oxides, carbon monoxide, particulate matter, sulfur dioxide, non-methane hydrocarbon, and for hazardous air pollutants (HAPs).

2.14 STARTING SYSTEM

Provide starting system for engine generator sets used in non-emergency applications.

2.14.1 Controls

Provide an engine control switch with functions including: run/start (manual), off/reset, and, automatic mode. Provide start-stop logic for adjustable cycle cranking and cool-down operation. Arrange the logic for fully automatic starting in accordance with paragraph AUTOMATIC ENGINE-GENERATOR-SET SYSTEM OPERATION. Provide electrical starting systems with an adjustable cranking limit device to limit cranking periods from 1 second up to the maximum duration.

2.14.2 Capacity

Provide starting system with sufficient capacity, at the maximum outdoor summer temperature specified to crank the engine without damage or overheating. The system must provide a minimum of three cranking periods with 15 second intervals between cranks. Each cranking period must have a maximum duration of 15 seconds. Starting must be accomplished using an adequately sized dc starter system with a positive shift solenoid to engage the starter motor and to crank the engine continuously for 60 seconds without overheating.

2.14.3 Electrical Starting

Manufacturers recommended dc system, utilizing a negative circuit ground. Starting motors must be in accordance with SAE ARP892.

2.14.3.1 Battery

Provide a starting battery system including the battery, battery rack, intercell connectors, spacers, automatic battery charger with overcurrent protection, metering and relaying. Provide battery in accordance with SAE J537. Size critical system components (rack, protection, etc.) to withstand the seismic acceleration forces specified. Provide lead-acid battery with sufficient capacity, at the minimum outdoor and maximum outdoor temperature specified, to provide the specified cranking periods. Valve-regulated lead-acid batteries are not acceptable.

Provide maintenance free, sealed, lead-acid, SAE Type D engine starting batteries. Batteries must have sufficient capacity to provide 60 seconds of continuous cranking of the engine in an ambient temperature of 84 degrees F.

2.14.3.2 Battery Charger

Provide a current-limiting battery charger, conforming to UL 1236, that automatically recharges the batteries. Submit battery charger sizing calculations. The charger must be capable of an equalize charging rate or recharging fully depleted batteries within 24 hours which is manually adjustable in a continuous range and a floating charge rate for maintaining the batteries at fully charged condition. Provide an ammeter to indicate charging rate. Provide a voltmeter to indicate charging voltage. Provide a timer for the equalize charging-rate setting. A battery is considered to be fully depleted when the output voltage falls to a value which will not operate the engine generator set and its components.

Provide 120 volt ac, enclosed, automatic equalizing, dual-rate, solid-state, constant voltage type battery charger with automatic ac line compensation. DC output must be voltage regulated and current limited. Charger must have two ranges, float and equalize, and must provide continuous taper charging. The charger must have a continuous output rating of not less than 10 amperes and must be sized to recharge the engine starting batteries in a minimum of 8 hours while providing the control power needs of the engine-generator set. Enclosure must be NEMA ICS 6, Type 1 or 3R as required by installation. The following accessories must be included:

- a. DC ammeter

- b. DC voltmeter
- c. Equalize light
- d. AC on light
- e. Low voltage light
- f. High voltage light
- g. Equalize test button/switch
- h. AC circuit breaker
- i. Low dc voltage alarm relay
- j. High dc voltage alarm relay
- k. Current failure relay
- l. AC power failure relay

2.14.4 Storage Batteries

Provide storage batteries of suitable rating and capacity to supply and maintain power for the remote alarm annunciator for a period of 90 minutes minimum without the voltage applied falling below 87.5 percent of normal. Provide a 120 volt ac automatic battery charger.

2.14.5 Starting Aids

Provide one or more of other following methods to assist engine starting.

2.14.5.1 Glow Plugs

Design glow plugs to provide sufficient heat for combustion of fuel within the cylinders to guarantee starting at an ambient temperature of -25 degrees F.

2.14.5.2 Jacket-Coolant Heaters

Mount a thermostatically controlled electric heater in the engine coolant jacketing to automatically maintain the coolant within plus or minus 3 degrees F of the control temperature. The heater must operate independently of engine operation so that starting times are minimized. Power for the heaters must be 120 volts ac. Include necessary equipment, piping, controls, wiring, and accessories.

2.14.5.2.1 Standby Rated Sets

The control temperature must be the temperature recommended by the engine manufacturer to meet the starting time specified at the minimum winter outdoor temperature.

2.14.5.3 Lubricating-Oil Heaters

Mount a thermostatically controlled electric heater in the engine lubricating-oil system to automatically maintain the oil temperature within plus or minus 3 degrees F of the control temperature. The heater

must operate independently of engine operation so that starting times are minimized. Power for the heaters must be 120 volts ac.

2.14.6 Exerciser

Provide exerciser

2.15 GOVERNOR

Provide a forward acting type engine speed governor system. Steady-state frequency band and frequency regulation (droop) must be in accordance with the operating limit values of the performance class specified in the paragraph PERFORMANCE CLASS.

Provide engine with a governor which maintains the frequency within a bandwidth of the rated frequency, over a steady-state load range of zero to 100 percent of rated output capacity. Configure the governor for safe manual adjustment of the speed/frequency during operation of the engine-generator set, without special tools, from 90 to 110 percent of the rated speed/frequency, over a steady state load range of 0 to 100 percent or rated capacity. Submit two complete sets of special tools required for maintenance (except for electronic governor handset). Special tools are those that only the manufacturer provides, for special purposes, or to reach otherwise inaccessible parts. Provide a suitable tool box for tools. Provide one handset for each electronic governor when required to indicate and/or change governor response settings. Maintain the midpoint of the frequency bandwidth linearly for steady-state loads over the range of zero to 100 percent of rated output capacity, with 3 percent droop configured for safe, manual, external adjustment of the droop from zero to 7 percent for droop governors.

2.16 GENERATOR

Provide synchronous type, one or two bearing, generator conforming to the performance criteria in NEMA MG 1, equipped with winding terminal housings in accordance with NEMA MG 1, equipped with an amortisseur winding, and directly connected to the engine. Submit calculations of the engine and generator output power capability, including efficiency and parasitic load data. Provide C Class F insulation.

- a. Select NEMA MG 1, Part 16, standby duty, and temperature rise of 130 degrees C for engine-generator sets which are expected to operate for less than 300 hours per year. Select NEMA MG 1, Part 22, continuous duty, and temperature rise of 105 degrees C for engine-generator sets expected to operate 300 hours or greater per year or rated 300 kW and above.
- b. Select 2/3 pitch design option for engine-generator sets rated 300 kW and above.
- c. Select 10-12 lead re-connectable for engine-generator sets rated 300 kW to 800 kW.
- d. For applications requiring high SCR loading or in harsh environments laden with salts and chemicals, select vacuum pressure impregnation (VPI) insulated coils. When engine-generator sets are rated 800 kW and larger, also select form wound coils.

- e. Provide salient-pole type, ac, brushless-excited, revolving field, air-cooled, self-ventilated, drip-proof guarded, coupled type, synchronous generator conforming to **NEMA MG 1**, Part 16, and **IEEE C50.12**. Generator must be rated for standby duty at 100 percent of the power rating of the engine-generator set as specified in paragraph ENGINE-GENERATOR SET RATINGS AND PERFORMANCE. Temperature rise of each of the various parts of the generator must not exceed 130 degrees C as measured by resistance, based on a maximum ambient temperature of 40 degrees C. Winding insulation must be Class H.
- f. Stator: Stator windings must be 2/3 pitch design, 10-12 lead re-connectable with VPI insulated coils.
- g. Rotor: The rotor must have connected amortisseur windings.
- h. Generator Space Heater: Provide 120 volt ac heaters. Heater capacity must be as recommended by the generator manufacturer to aid in keeping the generator insulation dry.
- i. Grounding: Provide non-corrosive steel grounding pads located at two opposite mounting legs.
- j. Filters: Provide manufacturer's standard generator cooling air filter assembly.
- k. Design generator to protect against mechanical, electrical and thermal damage due to vibration, 25 percent overspeeds, or voltages and temperatures at a rated output capacity of 110 percent for prime applications and 100 percent for standby applications.
- l. Provide generator ancillary equipment meeting the short circuit requirements of **NEMA MG 1**. Select drip-proof guarded option for generators without weatherproof enclosures.
- m. Submit manufacturer's standard data for each generator (prototype data at the specified rating or above is acceptable), listing the following information:
 - (1) Direct-Axis sub-transient reactance (per unit).
 - (2) The generator kW rating and short circuit current capacity (both symmetric and asymmetric).

2.16.1 Current Balance

At 100 percent rated output capacity, and load impedance equal for each of the 3 phases, the permissible current difference between any 2 phases must not exceed 2 percent of the largest current on either of the 2 phases. Submit certification stating that the flywheel has been statically and dynamically balanced and is capable of being rotated at 125 percent of rated speed without vibration or damage.

2.16.2 Voltage Balance

At any balanced load between 75 and 100 percent of rated output capacity, the difference in line-to-neutral voltage among the 3 phases must not exceed 1 percent of the average line-to-neutral voltage. For a single phase load condition, consisting of 25 percent load at unity power factor placed between any phase and neutral with no load on the other 2 phases,

the maximum simultaneous difference in line-to-neutral voltage between the phases must not exceed 3 percent of rated line to neutral voltage. The single-phase load requirement must be valid utilizing normal exciter and regulator control. The interpretation of the 25 percent load for single phase load conditions means 25 percent of rated current at rated phase voltage and unity power factor.

2.16.3 Waveform

The deviation factor of the line-to-line voltage at zero load and at balanced rated output capacity must not exceed 10 percent. The RMS of all harmonics must be less than 5.0 percent and that of any one harmonic less than 3.0 percent of the fundamental at rated output capacity. Design and configure engine-generator to meet the total harmonic distortion limits of [IEEE 519](#).

2.17 [EXCITER](#)

Provide brushless generator exciter. Provide semiconductor rectifiers that have a minimum safety factor of 300 percent for peak inverse voltage and forward current ratings for all operating conditions, including 110 percent generator output at [104 degrees F](#) ambient. The exciter and regulator in combination must maintain generator-output voltage within the limits specified.

Provide a brushless excitation system consisting of an exciter and rotating rectifier assembly integral with the generator and a voltage regulator. Insulation class for parts integral with the generator must be as specified in paragraph GENERATOR. System must provide a minimum short circuit of 300 percent rated engine-generator set current for at least 10 seconds. Steady state voltage regulation must be in accordance with the operating limit values of the performance class specified in the paragraph PERFORMANCE CLASS.

- a. Exciter and Rotating Rectifier Assembly: Rectifiers must be provided with surge voltage protection.
- b. Permanent Magnet Generator: Provide a voltage spike suppression device for permanent magnet generator (PMG) excitation systems.
- c. Voltage Regulator: Voltage regulator must be solid state or digital, automatic, three-phase sensing, volts per hertz type regulator. Regulator must receive its input power from a PMG. Voltage variation for any 40 degree C change over the operating temperature range must be less than plus or minus 1.0 percent. Operating temperature must be minus 40 degree C to plus 70 degree C. Voltage adjust range must be plus to minus 5.0 percent of nominal. Inherent regulator features must include over excitation shutdown.

2.17.1 Electromagnetic Interference (EMI) Suppression

Provide as an integral part of the generator and excitation system, EMI suppression complying with [MIL-STD-461](#).

2.18 VOLTAGE REGULATOR

Provide a solid-state voltage regulator, separate from the exciter, for each generator. Maintain the voltage within a bandwidth of the rated voltage, over a steady-state load range of zero to 100 percent of rated

output capacity. Configure regulator for safe manual adjustment of the engine-generator voltage output without special tools, during operation, from 90 to 110 percent of the rated voltage over the steady state load range of 0 to 100 percent of rated output capacity. Regulation drift exceeding plus or minus 0.5 percent for an ambient temperature change of 68 degrees F is not acceptable.

2.19 GENERATOR ISOLATION AND PROTECTION

Provide necessary devices for electrical protection and isolation of each engine-generator set and its ancillary equipment. The generator circuit breaker (IEEE Device 52) ratings must be consistent with the generator rated voltage and frequency, with continuous, short circuit withstand, and interrupting current ratings to match the generator capacity. Provide manually operated generator circuit breaker. Mount a set of surge capacitors at the generator terminals. Provide monitoring and control devices as specified in paragraph GENERATOR PANEL.

The generator circuit breaker must comply with UL 489 requirements for molded case, adjustable thermal magnetic trip type circuit breaker. The circuit breaker continuous current rating must be adequate for the power rating of the engine-generator set and the circuit breaker must be rated to withstand the short circuit current provided by the generator set. Provide circuit breaker in a NEMA ICS 6, Type 1 or 3R (as required for installation) enclosure mounted on the engine-generator set.

2.19.1 Switchboards

Provide free-standing, metal-enclosed, general purpose, 3-phase, 4-wire, 600 volt rated, with neutral bus and continuous ground bus, switchboards conforming to NEMA PB 2 and UL 891. Neutral bus and ground bus capacity must be full capacity. Provide panelboards conforming to NEMA PB 1. Provide enclosure designs, construction, materials and coatings suitable for the application and environment. Bus continuous current rating must be at least equal to the generator rating and correspond to the UL listed current ratings specified for panelboards and switchboards. Current withstand (short circuit rating) must be equal to the breaker interrupting rating. Provide copper buses.

2.19.2 Devices

Provide switches, circuit breakers, switchgear, fuses, relays, and other protective devices as specified in Section 26 28 01.00 10 COORDINATED POWER SYSTEM PROTECTION.

Furnish with respective pieces of equipment. Motors, controllers, contactors, and disconnects must conform to Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Provide electrical connections under Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Provide controllers and contactors with maximum of 120-volt control circuits, and auxiliary contacts for use with controls furnished. When motors and equipment furnished are larger than size indicated, the cost of providing additional electrical service and related work must be included under this section.

2.20 SAFETY SYSTEM

Provide and install devices, wiring, remote panels, and local panels, etc., as a complete system to automatically activate the appropriate signals and initiate the appropriate actions. Provide a safety system

with a self-test method to verify its operability. Provide alarm signals that have manual acknowledgment and reset devices. The alarm signal systems must reactivate for new signals after acknowledgment is given to any signal. Configure the systems so that loss of any monitoring device will be dealt with as an alarm on that system element.

2.20.1 Audible Signal

Provide audible alarm signal sound at a frequency of 70 Hz at a volume of 75 dB at 10 feet. The sound must be continuously activated upon alarm and silenced upon acknowledgment. Locate signal devices as shown.

2.20.2 Visual Signal

The visual alarm signal must be a panel light. The light must be normally off, activated to be blinking upon alarm. The light must change to continuously lit upon acknowledgement. If automatic shutdown occurs, the display must maintain activated status to indicate the cause of failure and must not be reset until cause of alarm has been cleared and/or restored to normal condition. Shutdown alarms must be red; all other alarms must be amber.

2.20.3 Alarms and Action Logic

2.20.3.1 Shutdown

Accomplish simultaneous activation of the audible signal, activation of the visual signal, stopping the engine, and opening the generator main circuit breakers.

2.20.3.2 Problem

Accomplish activation of the visual signal.

2.20.4 Safety Indications and Shutdowns

Provide a local alarm panel with the following shutdown and alarm functions in accordance with NFPA 110 level 2 mounted either on or adjacent to the engine generator set.

A remote alarm panel is required for audible alarms, e.g., in the control room.

Indicator Function (at battery voltage)			NFPA 110 Level 2 CV S RA
Overcrank			X X 0
Low water temperature			X NA 0
High engine temperature pre-alarm			0 NA NA
High engine temperature			X X 0

Indicator Function (at battery voltage)			NFPA 110 Level 2 CV S RA
Low lube oil pressure pre-alarm			NA NA NA
Low lube oil pressure			X X 0
Overspeed			X X 0
Low fuel main tank			0 NA 0
Low coolant level			X 0 X
EPS supplying load			0 NA NA
Control switch not in automatic position			X NA X
High battery voltage			0 NA NA
Low cranking voltage			0 NA NA
Low voltage in battery			0 NA NA
Battery charger ac failure			0 NA NA
Lamp test			X NA NA
Contacts for local and remote common alarm			X NA X
Audible alarm silencing switch			NA NA 0
Low starting air pressure			0 NA NA
Low starting hydraulic pressure			0 NA NA
Air shutdown damper when used			X X 0
Remote emergency stop			NA X NA

Indicator Function (at battery voltage)			NFPA 110 Level 2 CV S RA
Symbology: CV: Control panel-mounted visual. S: Shutdown of EPS indication. RA: Remote audible. Symbology: CV: Control panel-mounted visual. S: Shutdown of EPS indication. RA: Remote audible. X: Required. O: Optional. NA: Not applicable.			

2.20.5 Time-Delay on Alarms

For startup of the engine-generator set, install time-delay devices bypassing the low lubricating oil pressure alarm during cranking, and the coolant-fluid outlet temperature alarm. Submit the magnitude of monitored values which define alarm or action set points, and the tolerance (plus and/or minus) at which the devices activate the alarm or action for items contained within the alarm panels. The lube-oil time-delay device must return its alarm to normal status after the engine starts. The coolant time-delay device must return its alarm to normal status 5 minutes after the engine starts.

2.21 PANELS

Each panel must be of the type and kind necessary to provide specified functions. Mount panels on the engine-generator set base by vibration/shock absorbing type mountings. Mount instruments flush or semiflush. Provide convenient access to the back of panels to facilitate maintenance. Calibrate instruments using recognized industry calibration standards. Provide a panel identification plate identifying the panel function. Provide a plate identifying the device and its function for each instrument and device on the panel. Provide switch plates identifying the switch-position function.

2.21.1 Enclosures

Design enclosures for the application and environment, conforming to **NEMA ICS 6**. Locking mechanisms must be keyed alike.

Provide for each engine-generator set and fabricate from zinc coated or phosphatized and shop primed 16 gage minimum sheet steel in accordance with the manufacturer's standard design. Provide a complete, weatherproof enclosure for the engine, generator, and auxiliary systems and equipment. Support exhaust piping and silencer so that the turbocharger is not subjected to exhaust system weight or lateral forces generated in connecting piping that exceed the engine manufacturer's maximum allowed forces and moments. The housing must have sufficient louvered openings to allow entrance of outside air for engine and generator cooling at full load. Design louvered openings to exclude driving rain and snow. Provide properly arranged and sized, hinged panels in the enclosure to allow convenient access to the engine, generator, and control equipment for

maintenance and operational procedures. Provide hinged panels with spring type latches which must hold the panels closed securely and will not allow them to vibrate. Brace the housing internally to prevent excessive vibration when the set is in operation

2.21.2 Analog

Provide analog electrical indicating instruments in accordance with [UL 1437](#) with semi-flush mounting. Switchboard, switchgear, and control-room panel-mounted instruments must have 250 degree scales with an accuracy of not less than 99 percent. Unit-mounted instruments must be the manufacturer's standard [and](#) have 100 degree scales with an accuracy of not less than 98 percent. The instrument's operating temperature range must be [minus 4 to plus 158 degrees F](#). Distorted generator output voltage waveform of a crest factor less than 5 must not affect metering accuracy for phase voltages, hertz and amps.

2.21.3 Electronic

Electronic indicating instruments must be true RMS indicating instruments, 100 percent solid state, state-of-the-art, microprocessor controlled to provide specified functions. Provide control, logic, and function devices that are compatible as a system, sealed, dust and water tight, and that utilize modular components with metal housings and digital instrumentation. Provide an interface module to decode serial link data from the electronic panel and translate alarm, fault and status conditions to set of relay contacts. Instrument accuracy less than 98 percent for unit mounted devices and 99 percent for control room, panel mounted devices, throughout a temperature range of [minus 4 to 158 degrees F](#) is not acceptable. Provide LED or back lit LCD data display. Additionally, the display must provide indication of cycle programming and diagnostic codes for troubleshooting. Numeral height must be [0.5 inch](#).

2.21.4 Parameter Display

Provide indication or readouts of the tachometer, lubricating-oil pressure, ac voltmeter, ac ammeter, frequency meter, and safety system parameters. Specify a momentary switch for other panels.

2.22 SURGE PROTECTION

Electrical and electronic components must be protected from, or designed to withstand the effects of surges from switching and lightning.

2.23 AUTOMATIC ENGINE-GENERATOR-SET SYSTEM OPERATION

Provide fully automatic operation for the following operations: engine-generator set starting and load transfer upon loss of normal source; retransfer upon restoration of the normal source; sequential starting; paralleling, and load-sharing for multiple engine-generator sets; and stopping of each engine-generator set after cool-down. Devices must automatically reset after termination of their function.

2.23.1 Automatic Transfer Switch

Provide automatic transfer switches

2.23.2 Monitoring and Transfer

Provide devices to monitor voltage and frequency for the normal power source and each engine-generator set, and control transfer from the normal source and retransfer upon restoration of the normal source. Describe functions, actuation, and time delays.

2.24 MANUAL ENGINE-GENERATOR-SET SYSTEM OPERATION

Provide complete facilities for manual starting and testing of each set without load, loading and unloading of each set of with an energized bus.

2.25 STATION BATTERY SYSTEM

Provide a station battery system including the battery, battery rack, spacers, automatic battery charger and distribution panelboard with overcurrent protection, metering and relaying. Size components to withstand the seismic acceleration forces specified. Provide batteries that have a rated life of 20 years and a manufacturer's 5-year, no cost replacement guarantee.

2.25.1 Battery

Provide lead-acid battery sized in accordance with IEEE 485 and conforming to the requirements of IEEE 484. Valve-regulated lead-acid batteries are not acceptable. Provide battery environment temperature range between 28 and 77 degrees. The battery must be rated for the number of ampere hours recommended by the manufacturer at the 8-hour rate.

2.25.2 Battery Capacity

The battery must be rated for at least the number of ampere hours recommended by the manufacturer at the 8-hour rate, and must have sufficient capacity to serve the following loads without recharging for a period of 2 hours. At the end of the discharge period, the battery must have the capacity to simultaneously close and trip all the circuit breakers provided, based on a 1-minute load to final voltage of 11.3 volts per cell.

- a. Diesel-generator safety circuits.
- b. Switchgear indicating lights, control relays, protective relays, and other switchgear dc components as required for 24 hours.
- c. Voltage regulator (dc power supplies).
- d. Emergency-lighting and power load at 100 watts for 2 hours.

2.25.3 Battery Charger

Furnish a current-limiting, 24-volt battery charger to automatically recharge the batteries. Provide a charger that is capable of an equalize charging rate for recharging fully depleted batteries within 8 hours which is continuously adjustable and a floating-charge rate for maintaining the batteries in a fully charged condition. Equip the charger with a low-voltage alarm relay, 0- to 24-hour equalizing timer, an ammeter to indicate charging rate, and necessary circuit breakers. The charger must conform to the requirements of UL 1236. A battery is considered to be

fully depleted when the voltage falls to a level incapable of operating the equipment loads served by the battery.

2.26 BASE

Provide a steel base. Design the base to rigidly support the engine-generator set, ensure permanent alignment of rotating parts, be arranged to provide easy access to allow changing of lube-oil, and ensure that alignment is maintained during shipping and normal operation. The base must permit skidding in any direction during installation and must withstand and mitigate the affects of synchronous vibration of the engine and generator. Provide base with suitable holes for anchor bolts and jacking screws for leveling.

2.27 THERMAL INSULATION

Provide thermal insulation as specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

2.28 PAINTING AND FINISHING

Clean, prime and paint the engine-generator set in accordance with the manufacturer's standard color and practice.

2.29 FACTORY INSPECTION AND TESTS

Submit six complete reproducible copies of the factory inspection result on the checklist format specified below. Perform the factory tests on each engine-generator set. The component manufacturer's production line test is acceptable as noted. Run each engine-generator set for at least 1 hour at rated output capacity prior to inspections. Complete inspections and make all necessary repairs prior to testing. Use engine generator controls and protective devices that are provided by the generator set manufacturer as part of the standard package for factory tests. When controls and switchgear are not provided as part of the generator set manufacturer's standard package, the actual controls and protective devices provided for the project are not required to be used during the factory test. The Contracting Officer may provide one or more representatives to witness inspections and tests.

2.29.1 Factory Inspection

Perform inspections prior to beginning and after completion of testing of the assembled engine-generator set. Look for leaks, looseness, defects in components, proper assembly, etc. and note any item found to be in need of correction as a necessary repair. Use the following checklist for the inspection:

INSPECTION ITEM	GOOD	BAD	NOTES
Drive belts			
Governor and adjustments			
Engine timing mark			

INSPECTION ITEM	GOOD	BAD	NOTES
Starting motor			
Starting aids			
Coolant type and concentration			
Radiator drains			
Block coolant drains			
Coolant fill level			
All coolant line connections			
All coolant hoses			
Combustion air filter			
Combustion air silencer			
Lube oil type			
Lube oil sump drain			
Lube-oil filter			
Lube-oil-level indicator			
Lube-oil-fill level			
All lube-oil line connections			
All lube-oil lines			
Fuel type and amount			
All fuel-line connections			
All fuel lines			
Fuel filter			
Coupling and shaft alignment			
Voltage regulators			
Battery-charger connections			
All wiring connections			
Instrumentation			

INSPECTION ITEM	GOOD	BAD	NOTES
Hazards to personnel			
Base			
Nameplates			
Paint			
Exhaust-heat recovery unit			
Switchboard			

2.29.2 Factory Tests

Submit a letter giving notice of the proposed dates of factory inspections and tests at least 14 days prior to beginning tests, including:

- a. A detailed description of the manufacturer's procedures for factory tests at least 14 days prior to beginning tests.
- b. Six copies of the Factory Test data described below in 8-1/2 by 11 inch binders having a minimum of 3 rings from which material may readily be removed and replaced, including a separate section for each test. Separate sections by heavy plastic dividers with tabs. Provide full size (8-1/2 by 11 inch minimum) data plots showing grid lines, with full resolution.
 - (1) A detailed description of the procedures for factory tests.
 - (2) A list of equipment used, with calibration certifications.
 - (3) A copy of measurements taken, with required plots and graphs.
 - (4) The date of testing.
 - (5) A list of the parameters verified.
 - (6) The condition specified for the parameter.
 - (7) The test results, signed and dated.
 - (8) A description of adjustments made.

On engine-generator set tests where the engine and generator are required to be connected and operated together, the load power factor must be the power factor specified in the engine generator set parameter schedule .8 power factor. For engine-generator set with dual-fuel operating capability, perform the following tests using the primary fuel type. Perform electrical measurements in accordance with IEEE 120. Temperature limits in the rating of electrical equipment and for the evaluation of electrical insulation must be in accordance with IEEE 1. In the following tests where measurements are to be recorded after stabilization of an engine-generator set parameter (voltage, frequency, current, temperature,

etc.), stabilization is considered to have occurred when measurements are maintained within the specified bandwidths or tolerances, for a minimum of four consecutive readings. Tests specifically for the generator may be performed utilizing any prime mover.

- a. Insulation Resistance for Stator and Exciter Test, **IEEE 115** and **IEEE 43**, to the performance criteria in **NEMA MG 1**, Part 22. Generator manufacturer's production line test is acceptable.
- b. High Potential Test, in accordance with **IEEE 115** and **NEMA MG 1**, test voltage in accordance with **NEMA MG 1**. Generator manufacturer's production line test is acceptable.
- c. Winding Resistance Test, Stator and Exciter, in accordance with **IEEE 115**. Generator manufacturer's production line test is acceptable.
- d. Phase Balance Voltage Test, to the performance criteria specified in paragraph GENERATOR. This test can be performed with any prime mover. Generator manufacturer's production line test results are acceptable.
 - (1) Start and operate the generator at no load.
 - (2) Adjust a regulated phase voltage (line-to-neutral) to rated voltage.
 - (3) Read and record the generator frequency, line-to-neutral voltages, and the line-to-line voltages.
 - (4) Apply 75 percent rated load and record the generator frequency, line-to-neutral voltages, and the line-to-line voltages.
 - (5) Apply rated load and record the generator frequency, line-to-neutral voltages, and the line-to-line voltages.
 - (6) Calculate average line-neutral voltage and percent deviation of individual line-neutral voltages from average for each load condition.
- e. Current Balance on Stator Winding Test, by measuring the current on each phase of the winding with the generator operating at 100 percent of Rated Output Capacity, with the load impedance equal for each of the three phases: to the performance criteria specified in paragraph GENERATOR.
- f. Voltage Waveform Deviation and Distortion Test in accordance with **IEEE 115** to the performance criteria specified in paragraph GENERATOR. Use high-speed recording instruments capable of recording voltage waveform deviation and all distortion, including harmonic distortion. Include appropriate scales to provide a means to measure and interpret results.
- g. Voltage and Frequency Droop Test. Verify that the output voltage and frequency are within the specified parameters as follows:
 - (1) With the generator operating at no load, adjust voltage and frequency to rated voltage and frequency. Record the generator output frequency and line-line and line-neutral voltages.

- (2) Increase load to Rated Output Capacity. Record the generator output frequency and line-line and line-neutral voltages.
- (3) Calculate the percent droop for voltage and frequency with the following equations:

$$\text{Voltage droop percent} = \frac{(\text{No-Load Volts}) - (\text{Rated Capacity Volts})}{(\text{Service-Load Volts})} \times 100$$

$$\text{Frequency droop percent} = \frac{(\text{No-Load Hertz}) - (\text{Rated Capacity Hertz})}{(\text{Service-Load Hertz})} \times 100$$

- (4) Repeat steps 1 through 3 two additional times without making any adjustments.
- h. Frequency and Voltage Stability and Transient Response. Verify that the engine-generator set responds to addition and dropping of blocks of load in accordance with the transient response requirements. Document maximum voltage and frequency variation from bandwidth and verify that voltage and frequency return to and stabilize within the specified bandwidth, within the specified response time period. Document results in tabular form and with high resolution, high speed strip chart recorders or comparable digital recorders, as approved by the Contracting Officer. Include the following tabular data:
- (1) Ambient temperature (at 15 minute intervals).
 - (2) Generator output current (before and after load changes).
 - (3) Generator output voltage (before and after load changes).
 - (4) Frequency (before and after load changes).
 - (5) Generator output power (before and after load changes).
 - (6) Graphic representations must include the actual instrument trace of voltage and frequency showing: charts marked at start of test; observed steady-state band; mean of observed band; momentary overshoot and undershoot (generator terminal voltage and frequency) and recovery time for each load change together with the voltage and frequency maximum and minimum trace excursions for each steady state load condition prior to and immediately following each load change. Generator terminal voltage and frequency transient recovery time for each step load increase and decrease.
 - (a) Perform and record engine manufacturer's recommended pre-starting checks and inspections.
 - (b) Start the engine, make and record engine manufacturer's after-starting checks and inspections during a reasonable warm-up period and no load. Verify stabilization of voltage and frequency within specified bandwidths.
 - (c) With the unit at no load, apply the Maximum Step Load Increase.

- (d) Apply load in steps equal to the Maximum Step Load Increase until the addition of one more step increase will exceed the Service Load.
 - (e) Decrease load to the unit such that addition of the Maximum Step Load Increase will load the unit to 100 percent of Service Load.
 - (f) Apply the Maximum Step Load Increase.
 - (g) Decrease load to zero percent in steps equal to the Maximum Step Load Decrease.
 - (h) Repeat steps (c) through (g).
- i. Test Voltage Unbalance with Unbalanced Load (Line-to-Neutral) to the performance criteria specified in paragraph GENERATOR. [Prototype test](#) data is acceptable in lieu of the actual test. Submit manufacturer's standard certification that prototype tests were performed for the generator model proposed. This test may be performed using any prime mover.
- (1) Start and operate the generator set at rated voltage, no load, rated frequency, and under control of the voltage regulator. Read and record the generator frequency, line-to-neutral voltages, and the line-to-line voltages.
 - (2) Apply the specified load between terminals L_1-L_2 , L_2-L_0 , and L_3-L_0 in turn. Record all instrument readings at each line-neutral condition.
 - (3) Express the greatest difference between any two of the line-to-line voltages and any two of the line-to-neutral voltages as a percent of rated voltage.
 - (4) Compare the largest differences expressed in percent with the maximum allowable difference specified.

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with all details of the job, perform a [Site Visit](#) to verify the information shown on the drawings, before performing any work. Submit a letter stating the date the site was visited and listing discrepancies found. Notify the Contracting Officer in writing of any discrepancies.

3.2 [GENERAL INSTALLATION](#)

Provide clear space for operation and maintenance in accordance with [NFPA 70](#) and [IEEE C2](#). Submit a copy of the manufacturer's installation procedures and a detailed description of the manufacturer's recommended break-in procedure. Install pipe, duct, conduit, and ancillary equipment to facilitate easy removal and replacement of major components and parts of the engine-generator set.

3.3 PIPING INSTALLATION

Weld piping. Provide flanged valve connections. Provide flanged connections at equipment. Provide threaded connections to the engine if the manufacturers standard connection is threaded. Except where otherwise specified, use welded flanged fittings to allow for complete dismantling and removal of each piping system from the facility without disconnecting or removing any portion of any other system's equipment or piping. Make connections to equipment with vibration isolation-type flexible connectors. Support and align piping and tubing to prevent stressing of flexible hoses and connectors. Flash pipes extending through the roof. Install piping clear of windows, doors and openings, to permit thermal expansion and contraction without damage to joints or hangers, and install a 1/2 inch drain valve with cap at each low point.

The installation of gas engines must conform to the requirements of NFPA 37 and its references therein, including NFPA 54, NFPA 58, and ASME B31.3.

3.3.1 Support

Provide hangers, inserts, and supports to accommodate any insulation and conforming to MSS SP-58. Space supports no more than 7 feet on center for pipes 2 inches in diameter or less, no more than 12 feet on center for pipes larger than 2 inches but smaller than 4 inches in diameter, and not more than 17 feet on center for pipes larger than 4 inches in diameter. Provide supports at pipe bends or change of direction.

3.3.1.1 Ceiling and Roof

Support exhaust piping with appropriately sized Type 41 single pipe roll and threaded rods; support all other piping with appropriately sized Type 1 clevis and threaded rods.

3.3.1.2 Wall

Make wall supports for pipe by suspending the pipe from appropriately sized Type 33 brackets with the appropriate ceiling and roof pipe supports.

3.3.2 Flanged Joints

Provide flanges that are Class 125 type, drilled, and of the proper size and configuration to match the equipment and engine connections. Provide gasketed flanged joints that are square and tight.

3.3.3 Cleaning

After fabrication and before assembly, piping interiors must be manually wiped clean of debris.

3.3.4 Pipe Sleeves

Fit pipes passing through construction such as ceilings, floors, or walls with sleeves. Extend each sleeve through and fasten in its respective structure and cut flush with each surface. Build the structure tightly to the sleeve. The inside diameter of each sleeve must be minimum 1/2 inch, and where pipes pass through combustible materials 1 inch larger than the outside diameter of the passing pipe or pipe insulation/covering.

3.4 ELECTRICAL INSTALLATION

Perform electrical installation in compliance with NFPA 70, IEEE C2, and Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. For vibration isolation, provide flexible fittings for conduit, cable trays, and raceways attached to engine-generator sets; provide flexible stranded conductor for metallic conductor cables installed on the engine generator set and from the engine generator set to equipment not mounted on the engine generator set; and provide crimp-type terminals or lugs for terminations of conductors on the engine generator set.

3.5 FIELD PAINTING

Perform field touchup on all generator enclosures. Use manufacturers recommendations for finishing procedures for generator enclosures.

3.6 ONSITE INSPECTION AND TESTS

Perform and report on factory tests and inspections prior to shipment. Provide certified copies of manufacturer's test data and results. Test procedures must conform to ASME, IEEE, and ANSI standards, and to ISO requirements on testing, as appropriate and applicable. The manufacturer performing the tests must provide equipment, labor, and consumables necessary for tests and measuring and indicating devices must be certified to be within calibration. Tests must indicate satisfactory operation and attainment of specified performance. If satisfactory, equipment tested will be given a tentative approval. Equipment must not be shipped before approval of the factory test reports for the following tests.

Submit a letter giving notice of the proposed dates of onsite inspections and tests at least 14 days prior to beginning tests.

- a. Submit a detailed description of the Contractor's procedures for onsite tests including the test plan and a listing of equipment necessary to perform the tests at least 14 days prior to beginning tests.
- b. Submit six copies of the onsite test data described below in 8-1/2 by 11 inch binders having a minimum of 3 rings from which material may readily be removed and replaced, including a separate section for each test. Separate sections by heavy plastic dividers with tabs. Provide full size (8-1/2 by 11 inch minimum) data plots showing grid lines, with full resolution.
 - (1) A detailed description of the procedures for onsite tests.
 - (2) A list of equipment used, with calibration certifications.
 - (3) A copy of measurements taken, with required plots and graphs.
 - (4) The date of testing.
 - (5) A list of the parameters verified.
 - (6) The condition specified for the parameter.
 - (7) The test results, signed and dated.
 - (8) A description of adjustments made.

3.6.1 Test Conditions

3.6.1.1 Data

Make and record measurements of all parameters necessary to verify that each set meets specified parameters. If the results of any test step are not satisfactory, make adjustments, replacements, or repairs and repeat the step until satisfactory results are obtained. Unless otherwise indicated, record data in 15 minute intervals during engine-generator set operation and include: readings of all engine-generator set meters and gauges for electrical and power parameters; oil pressure; ambient temperature; and engine temperatures available from meters and gauges supplied as permanent equipment on the engine-generator set. Perform electrical measurements in accordance with [IEEE 120](#). Definitions of terms are in accordance with [IEEE 100](#). Provide temperature limits in the rating of electrical equipment and for the evaluation of electrical insulations in accordance with [IEEE 1](#).

3.6.1.2 Power Factor

Submit the generator capability curve showing generator kVA output capability (kW vs. kvar) for both leading and lagging power factors ranging from 0 to 1.0. For all engine-generator set operating tests the load power factor must be .8 power factor.

3.6.1.3 Contractor Supplied Items

Provide equipment and supplies required for inspections and tests including fuel, test instruments, and loadbanks at the specified power factors.

3.6.1.4 Instruments

Verify readings of panel gauges, meters, displays, and instruments provided as permanent equipment during test runs, using test instruments of greater precision and accuracy. Test instrument accuracy must be within the following: current plus or minus 1.5 percent, voltage plus or minus 1.5 percent, real power plus or minus 1.5 percent, reactive power plus or minus 1.5 percent, power factor plus or minus 3 percent, frequency plus or minus 0.5 percent. Calibrate test instruments by a recognized standards laboratory within 30 days prior to testing.

3.6.1.5 Sequence

Provide the sequence of testing as specified in the approved testing plan unless variance is authorized by the Contracting Officer. Perform field testing in the presence of the Contracting Officer. Schedule and sequence tests in order to optimize run-time periods; however, follow the general order of testing: Construction Tests; Inspections; Pre-operational Tests; Safety Run Tests; Performance Tests; and Final Inspection.

3.6.2 Construction Tests

Perform individual component and equipment functional tests for fuel piping, coolant piping, and lubricating-oil piping, electrical circuit continuity, insulation resistance, circuit protective devices, and equipment not provided by the engine-generator set manufacturer prior to connection to the engine-generator set.

3.6.2.1 Piping Test

- a. Flush lube-oil and fuel-oil piping with the same type of fluid intended to flow through the piping, until the outflowing fluid has no obvious sediment or emulsion.
- b. Test fuel piping which is external to the engine-generator set in accordance with **NFPA 30**. Pressure all remaining piping which is external to the engine-generator set with air pressure at 150 percent of the maximum anticipated working pressure, but not less than **150 psi**, for a period of 2 hours to prove the piping has no leaks. If piping is to be insulated, perform the test before the insulation is applied.

3.6.2.2 Electrical Equipment Tests

- a. Perform low-voltage cable insulation integrity tests for cables connecting the generator breaker to the automatic transfer switch . Test low-voltage cable, complete with splices, for insulation resistance after the cables are installed, in their final configuration, ready for connection to the equipment, and prior to energization. Apply a test voltage of 500 volts dc for one minute between each conductor and ground and between all possible combinations conductors in the same trench, duct, or cable, with all other conductors in the same trench, duct, or conduit. Provide the minimum value of insulation as follows:
 - (1) $R \text{ in meg-ohms} = (\text{rated voltage in kV plus } 1) \times 304.8 / (\text{length of cable in meters})$
 - (2) $R \text{ in meg-ohms} = (\text{rated voltage in kV plus } 1) \times 1000 / (\text{length of cable in feet})$
 - (3) Each cable failing this test must be repaired or replaced. The repair cable must be retested until failures have been eliminated.
- b. Perform medium-voltage cable insulation integrity tests for cables connecting the generator breaker to the main disconnect switch. After installation and before the operating test or connection to an existing system, perform a high potential test on the medium-voltage cable system. Apply direct-current voltage on each phase conductor of the system by connecting conductors as one terminal and connecting grounds of metallic shields or sheaths of the cable as the other terminal for each test. Prior to making the test, isolate the cables by opening applicable protective devices and disconnecting equipment. Conduct the test with all splices, connectors, and terminations in place. Provide the method, voltage, length of time, and other characteristics of the test for initial installation in accordance with **NEMA WC 74/ICEA S-93-639** for the particular type of cable installed, except provide 28kV and 35kV insulation test voltages in accordance with either **AEIC CS8** or **AEIC CS8** as applicable, and do not exceed the recommendations of **IEEE 404** for cable joints and **IEEE 48** for cable terminations unless the cable and accessory manufacturers indicate higher voltages are acceptable for testing. Should any cable fail due to a weakness of conductor insulation or due to defects or injuries incidental to the installation or because of improper installation of cable, cable joints, terminations, or other connections, make necessary repairs or replace cables as directed. Retest repaired or replaced cables.

- c. Ground-Resistance Tests. Measure the resistance of each grounding electrode system using the fall-of-potential method defined in IEEE 81. On systems consisting of interconnected ground rods, perform tests after interconnections are complete. Take measurements in normally dry weather, not less than 48 hours after rainfall. Provide site diagram indicating location of test probes with associated distances, and provide a plot of resistance vs. distance. The combined resistance of separate systems may be used to meet the requirements resistance, but the specified number of electrodes must still be provided as follows:
- (1) Single rod electrode - 25 ohms.
 - (2) Multiple rod electrodes - 5 ohms.
- d. Examine and test circuit breakers and switchgear in accordance with the manufacturer's published instructions for functional testing.

3.6.3 Inspections

Perform the following inspections jointly by the Contracting Officer and the Contractor, after complete installation of each engine-generator set and its associated equipment, and prior to startup of the engine-generator set. Submit a letter certifying that all facilities are complete and functional; that each system is fully functional; and that each item of equipment is complete, free from damage, adjusted, and ready for beneficial use. Perform checks applicable to the installation. Document and submit the results of those which are physical inspections (I) in accordance with paragraph SUBMITTALS. Present manufacturer's data for the inspections designated (D) at the time of inspection. Verify that equipment type, features, accessibility, installation and condition are in accordance with the contract specification. Provide manufacturer's statements to certify provision of features which cannot be verified visually.

Drive belts	I
Governor type and features	I
Engine timing mark	I
Starting motor	I
Starting aids	I
Coolant type and concentration	D
Radiator drains	I
Block coolant drains	I
Coolant fill level	I
Coolant line connections	I

Coolant hoses	I
Combustion air filter	I
Intake air silencer	I
Lube oil type	D
Lube oil sump drain	I
Lube-oil filter	I
Lube-oil level indicator	I
Lube-oil fill level	I
Lube-oil line connections	I
Lube-oil lines	I
Fuel type	D
Fuel level	I
Fuel-line connections	I
Fuel lines	I
Fuel filter	I
Access for maintenance	I
Voltage regulator	I
Battery-charger connections	I
Wiring and terminations	I
Instrumentation	I
Hazards to personnel	I
Base	I
Nameplates	I
Paint	I
Exhaust-heat system	I
Exhaust muffler	I
Switchboard	I

Switchgear	I
Access provided to controls	I
Enclosure is weather resistant	I
Engine and generator mounting bolts (application)	I

3.6.4 Engine Tests

Perform customary commercial factory tests in accordance with [ISO 3046](#) on each engine and associated engine protective device, including, but not limited to the following:

- Perform dynamometer test at rated power. Record horsepower at rated speed and nominal characteristics such as lubricating oil pressure, jacket water temperature, and ambient temperature.
- Test and record the values that the low oil pressure alarm and protective shutdown devices actuate prior to assembly on the engine.
- Test and record values that the high jacket water temperature alarm and protective shutdown devices actuate prior to assembly on the engine.

3.6.5 Generator Tests

Tests must be performed on the complete factory assembled generator prior to shipment. Conduct tests in accordance with [IEEE 115](#), and [NEMA MG 1](#).

3.6.5.1 Routine Tests

Perform the following routine tests on the generators and their exciters:

- Resistance of armature and field windings.
- Mechanical balance.
- Phases sequence.
- Open circuit saturation curve and phase (voltage) balance test.
- Insulation resistance of armature and field windings.
- High potential test

3.6.5.2 Design Tests

Submit the following design tests made on prototype machines that are physically and electrically identical to the generators specified.

- Temperature rise test
- Short circuit saturation curve and current balance test

3.6.6 Assembled Engine-Generator Set Tests

For engine/generators 250kw and less sSubmit the following tests made on

prototype machines that are physically and electrically identical to the engine-generator set specified. For engine generators greater than 250kw perform the following tests on the assembled engine-generator set.:

3.6.6.1 Initial Stabilization Readings

Operate the engine-generator set and allow the set to stabilize at rated kW at rated power factor, rated voltage, and rated frequency. During this period record instrument readings for output power (kW), terminal voltage, line current, power factor, frequency (rpm) generator (exciter) field voltage and current, lubricating oil pressure, jacket water temperature, and ambient temperature at minimum intervals of 15 minutes. Adjust the load, voltage, and frequency to maintain rated load at rated voltage and frequency. Adjustments to load, voltage, or frequency controls must be recorded on the data sheet at the time of adjustment. Stabilization must be considered to have occurred when four consecutive voltage and current recorded readings of the generator (or exciter) field either remain unchanged or have only minor variations about an equilibrium condition with no evident continued increase or decrease in value after the last adjustment to the load, voltage, or frequency has been made.

3.6.6.2 Regulator Range Test

Remove load and record instrument readings (after transients have subsided). Adjust voltage to the maximum attainable value or to a value just prior to actuation of the overvoltage protection device. Apply rated load and adjust voltage to the minimum attainable value or a value just prior to activation of the under-voltage protection device. The data sheets must indicate the voltage regulation as a percent of rated voltage and the maximum and minimum voltages attainable. Voltage regulation must be defined as follows:

$$\text{Percent Regulation} = \frac{((\text{No-Load Voltage}) - (\text{Rated-Load Voltage})) \times 100}{(\text{Rated-Load Voltage})}$$

3.6.6.3 Frequency Range Test

Adjust the engine-generator set frequency for the maximum attainable frequency at rated load. Record instrument readings. Adjust the engine-generator set frequency for the specified minimum attainable frequency at rated load. Record instrument readings. Reduce the load to zero and adjust the engine-generator set frequency for the maximum attainable frequency. Record instrument readings. Adjust the engine-generator set frequency for the minimum attainable frequency. Record instrument readings. The data sheet must show the maximum and minimum frequencies attained at rated load, and at no load.

3.6.6.4 Transient Response Test

Drop the load to no load and re-apply rated load three times to ensure that the no load and rated load voltage and frequency values are repeatable and that the frequency and voltage regulation is within the limits specified. Record generator terminal voltage and frequency using a high speed strip chart recorder. The data sheet must show the following results:

a. Frequency

- (1) Stability bandwidth or deviation in percent of rated frequency.
- (2) Recovery time.
- (3) Overshoot and undershoot.

b. Voltage

- (1) Stability bandwidth or deviation in percent of rated voltage.
- (2) Recovery time.
- (3) Overshoot and undershoot.

3.6.7 Pre-operational Tests

3.6.7.1 Insulation Test

Test generator and exciter circuits insulation resistance in accordance with [IEEE 43](#). Take stator readings including generator leads to switchboard at the circuit breaker. Record results of insulation resistance tests. Readings must be within limits specified by the manufacturer. Verify mechanical operation, insulation resistance, protective relay calibration and operation, and wiring continuity of switchboard assembly. Do not damage generator components during test.

3.6.7.2 Engine-Generator Connection Coupling Test

When the generator provided is a two-bearing machine, inspect and check the engine-generator connection coupling by dial indicator to prove that no misalignment has occurred. Use the dial indicator to measure variation in radial positioning and axial clearance between the coupling halves. Take readings at four points, spaced 90 degrees apart. Align solid couplings and pin-type flexible couplings within a total indicator reading of [0.0005 to 0.001 inch](#) for both parallel and angular misalignment. For gear-type or grid-type couplings, [0.002 inch](#) will be acceptable.

3.6.8 Safety Run Test

For the following tests, repeat the associated safety tests if any parts are changed, or adjustments made to the generator set, its controls, or auxiliaries.

- a. Perform and record engine manufacturer's recommended prestarting checks and inspections.
- b. Start the engine, record the starting time, make and record engine manufacturer's after-starting checks and inspections during a reasonable warm-up period.
- c. Activate the manual emergency stop switch and verify that the engine stops.
- d. Remove the high and pre-high lubricating oil temperature sensing elements from the engine and temporarily install a temperature gauge in their normal locations on the engine (required for safety, not for recorded data). Where necessary provide temporary wiring harness to connect the sensing elements to their permanent electrical leads.

- e. Start the engine, record the starting time, make and record engine manufacturer's after-starting checks and inspections during a reasonable warm-up period. Operate the engine-generator set at no load until the output voltage and frequency stabilize. Monitor the temporarily installed temperature gauges. If either temperature reading exceeds the value required for an alarm condition, activate the manual emergency stop switch.
- f. Immerse the elements in a vessel containing controlled-temperature hot oil and record the temperature at which the pre-high alarm activates and the temperature at which the engine shuts down. Remove the temporary temperature gauges and reinstall the temperature sensors on the engine.
- g. Remove the high and pre-high coolant temperature sensing elements from the engine and temporarily install a temperature gauge in their normal locations on the engine (required for safety, not for recorded data). Where necessary provide temporary wiring harness to connect the sensing elements to their permanent electrical leads.
- h. Start the engine, record the starting time, make and record engine manufacturer's after-starting checks and inspections during a reasonable warm-up period. Operate the engine generator-set at no load until the output voltage and frequency stabilize.
- i. Immerse the elements in a vessel containing controlled-temperature hot oil and record the temperature at which the pre-high alarm activates and the temperature at which the engine shuts down. Remove the temporary temperature gauges and reinstall the temperature sensors on the engine.
- j. Start the engine, record the starting time, make and record engine manufacturer's after-starting checks and inspections during a reasonable warm-up period.
- k. Operate the engine generator-set for at least 2 hours at 75 percent of Service Load.
- l. Verify proper operation and set-points of gauges and instruments.
- m. Verify proper operation of ancillary equipment.
- n. Manually adjust the governor to increase engine speed past the over-speed limit. Record the RPM at which the engine shuts down.
- o. Start the engine, record the starting time, make and record engine manufacturer's after-starting checks and inspections and operate the engine generator-set for at least 15 minutes at 75 percent of Service Load.
- p. Manually adjust the governor to increase engine speed to within 2 percent of the over-speed trip speed previously determined and operate at that point for 5 minutes. Manually adjust the governor to the rated frequency.
- q. Manually fill the day tank to a level above the overflow limit. Record the level at which the overflow alarm sounds. Verify shutdown of the fuel transfer pump. Drain the day tank down below the overflow limit.

- r. Shut down the engine. Remove the time-delay low lube oil pressure alarm bypass and try to start the engine.
- s. Attach a manifold to the engine oil system (at the oil pressure sensor port) that contains a shutoff valve in series with a connection for the engine's oil pressure sensor followed by an oil pressure gauge ending with a bleed valve. Move the engine's oil pressure sensor from the engine to the manifold. Open the manifold shutoff valve and close the bleed valve.
- t. Start the engine, record the starting time, make and record engine manufacturer's after-starting checks and inspections and operate the engine generator-set for at least 15 minutes at 75 percent of Service Load.
- u. Close the manifold shutoff valve. Slowly allow the pressure in the manifold to bleed off through the bleed valve while watching the pressure gauge. Record the pressure at which the engine shuts down. Catch oil spillage from the bleed valve in a container. Add the oil from the container back to the engine, remove the manifold, and reinstall the engine's oil pressure sensor on the engine.
- v. Start the engine, record the starting time, make and record engine manufacturer's after-starting checks and inspections and operate the engine generator-set for at least 15 minutes at 100 percent of Service Load. Record the maximum sound level in each frequency band at a distance of 75 feet from the end of the exhaust and air intake piping directly along the path of intake and discharge for horizontal piping; or at a radius of 7 feet from the engine at 45 degrees apart in all directions for vertical piping. If a sound limiting enclosure is provided, modify or replace the enclosure, the muffler, and intake silencer must be modified or replaced as required to meet the sound requirements contained within this specification. If a sound limiting enclosure is not provided, the muffler and air intake silencer as required to meet the sound limitations of this specification. If the sound limitations can not be obtained by modifying or replacing the muffler and air intake silencer, notify the Contracting Officers Representative and provide a recommendation for meeting the sound limitations.
- w. Manually drain off fuel slowly from the day tank to empty it to below the low fuel level limit and record the level at which the audible alarm sounds. Add fuelback to the day tank to fill it above low level alarm limits.

3.6.9 Performance Tests

In the following tests, where measurements are to be recorded after stabilization of an engine-generator set parameter (voltage, frequency, current, temperature, etc.), stabilization is considered to have occurred when measurements are maintained within the specified bandwidths or tolerances, for a minimum of four consecutive readings. For the following tests, repeat the associated tests if any parts are changed, or adjustments made to the generator set, its controls, or auxiliaries.

3.6.9.1 Continuous Engine Load Run Test

Test the engine-generator set and ancillary systems at service load to demonstrate durability; verify that heat of extended operation does not

adversely affect or cause failure in any part of the system; and check all parts of the system. If the engine load run test is interrupted for any reason, repeat the entire test. Accomplish the engine load run test during daylight hours, with an average ambient temperature of 85 degrees F, . After each change in load in the following test, measure the vibration at the end bearings (front and back of engine, outboard end of generator) in the horizontal, vertical, and axial directions. Verify that the vibration is within the allowable range. Take data taken at 15 minute intervals and include the following:

Electrical: Output amperes, voltage, real and reactive power, power factor, frequency.

Pressure: Lube-oil.

Temperature: Coolant, Lube-oil, Exhaust, Ambient.

- a. Perform and record engine manufacturer's recommended prestarting checks and inspections. Include as a minimum checking of coolant fluid, fuel, and lube-oil levels.
- b. Start the engine, make and record engine manufacturer's after-starting checks and inspections during a reasonable warmup period.
- c. Operate the engine generator-set for 2 hours at 75 percent of Service Load.
- d. Increase load to 100 percent of Service Load and operate the engine generator-set for 4 hours.
- e. For prime rated units, increase load to 110 percent of Service Load and operate the engine generator-set for 2 hours.
- f. Decrease load to 100 percent of Service Load and operate the engine generator-set for 2 hours or until all temperatures have stabilized.
- g. Remove load from the engine-generator set.

3.6.9.2 Voltage and Frequency Droop Test

For the following steps, verify that the output voltage and frequency return to and stabilize within the specified bandwidth values following each load change. Record the generator output frequency and line-line and line-neutral voltages following each load change.

- a. With the generator operating at no load, adjust voltage and frequency to rated voltage and frequency.
- b. Increase load to 100 percent of Rated Output Capacity. Record the generator output frequency and line-line and line-neutral voltages.
- c. Calculate the percent droop for voltage and frequency with the following equations.

$$\text{Voltage droop percent} = \frac{\text{No-load volts} - \text{rated output capacity volts}}{\text{Rated output capacity volts}} \times 100$$

$$\text{Frequency droop percent} = \frac{\text{No load hertz} - \text{rated output capacity hertz}}{\text{Rated output capacity hertz}} \times 100$$

----- x 100
Rated output capacity volts

- d. Repeat steps a. through c. two additional times without making any adjustments.

3.6.9.3 Voltage Regulator Range Test

- a. While operating at no load, verify that the voltage regulator adjusts from 90 to 110 percent of rated voltage.
- b. Increase load to 100 percent of Rated Output Capacity. Verify that the voltage regulator adjusts from 90 to 110 percent of rated voltage.

3.6.9.4 Governor Adjustment Range Test

- a. While operating at no load, verify that the governor adjusts from 90 to 110 percent of rated frequency.
- b. Increase load to 100 percent of Rated Output Capacity. Verify that the governor adjusts from 90 to 110 percent of rated frequency.

3.6.9.5 Frequency and Voltage Stability and Transient Response

Verify that the engine-generator set responds to addition and dropping of blocks of load in accordance with the transient response requirements. Document maximum voltage and frequency variation from bandwidth and verify that voltage and frequency return to and stabilize within the specified bandwidth, within the specified response time period. Document results in tabular form and with high resolution, high speed strip chart recorders or comparable digital recorders, as approved by the Contracting Officer. Include the following tabular data:

- (1) Ambient temperature (at 15 minute intervals).
- (2) Generator output current (before and after load changes).
- (3) Generator output voltage (before and after load changes).
- (4) Frequency (before and after load changes).
- (5) Generator output power (before and after load changes).
- (6) Include the actual instrument trace of voltage and frequency in graphic representations showing:

Charts marked at start of test; observed steady-state band; mean of observed band; momentary overshoot and undershoot (generator terminal voltage and frequency) and recovery time for each load change together with the voltage and frequency maximum and minimum trace excursions for each steady state load condition prior to and immediately following each load change. Generator terminal voltage and frequency transient recovery time for each step load increase and decrease.

- a. Perform and record engine manufacturer's recommended prestarting checks and inspections.
- b. Start the engine, make and record engine manufacturer's after-starting checks and inspections during a reasonable warm-up period and no

load. Verify stabilization of voltage and frequency within specified bandwidths.

- c. With the unit at no load, apply the Maximum Step Load Increase.
- d. Apply load in steps equal to the Maximum Step Load Increase until the addition of one more step increase will exceed the Service Load.
- e. Decrease load to the unit such that addition of the Maximum Step Load Increase will load the unit to 100 percent of Service Load.
- f. Apply the Maximum Step Load Increase.
- g. Decrease load to zero percent in steps equal to the Maximum Step Load Decrease.
- h. Repeat steps c. through g.

3.6.10 Automatic Operation Tests

Test the automatic operating system to demonstrate automatic starting, loading and unloading of each engine-generator set. Utilize load banks at the indicated power factor for this test, and the loading sequence is the indicated sequence. Record load-sharing characteristics during all operations. Perform this test for a minimum of two successive, successful tests. Include the following data:

- (1) Ambient temperature (at 15 minute intervals).
 - (2) Generator output current (before and after load changes).
 - (3) Generator output voltage (before and after load changes).
 - (4) Generator output frequency (before and after load changes).
 - (5) Power division and exchange between generator sets.
 - (6) Real and reactive power on each set.
- a. Initiate loss of the preferred power source and verify the specified sequence of operation.
 - b. Verify resetting of automatic starting and transfer logic.

3.6.11 Automatic Operation Tests for Stand-Alone Operation

Test the automatic loading system to demonstrate automatic starting, and loading and unloading of each engine-generator set. Utilize the actual loads to be served for this test, and the loading sequence is the indicated sequence. Perform this test for a minimum of two successive, successful tests. Include the following data:

- (1) Ambient temperature (at 15 minute intervals).
- (2) Generator output current (before and after load changes).
- (3) Generator output voltage (before and after load changes).
- (4) Generator output frequency (before and after load changes).

- a. Initiate loss of the primary power source and verify automatic sequence of operation.
- b. Restore the primary power source and verify sequence of operation.
- c. Verify resetting of controls to normal.

3.7 GROUNDING

NFPA 70 and IEEE C2, except that grounding systems must have a resistance to solid earth ground not exceeding 5 ohms.

3.7.1 Engine-Generator Set Grounding

Provide separate copper grounding conductors and connect them to the ground system as indicated. When work in addition to that indicated or specified is required to obtain the specified ground resistance, the provision of the contract covering "Changes" must apply.

3.7.2 Connections

Make joints in grounding conductors by exothermic weld or compression connector. Exothermic welds and compression connectors must be installed as specified.

3.7.3 Grounding and Bonding Equipment

UL 467, except as indicated or specified otherwise.

3.8 START-UP ENGINEER

Provide the services of a qualified factory trained start-up engineer, regularly employed by the engine-generator set manufacturer. The start-up services must include conducting preliminary operations and functional acceptance tests. The start-up engineer must be present at the engine generator set installation-site, full-time, while preliminary operations and functional acceptance tests are being conducted.

3.9 PREREQUISITES FOR FUNCTIONAL ACCEPTANCE TESTING

Completion of the following requirements is mandatory prior to scheduling functional acceptance tests for the engine-generator set and auxiliary equipment.

3.9.1 Piping Tests

Complete as specified

3.9.2 Performance of Acceptance Checks and Tests

The acceptance checks and tests must be accomplished by the testing organization as described in Section 26 08 00 APPARATUS INSPECTION AND TESTING.

3.9.3 Generator Sets

Complete as specified in the paragraph ACCEPTANCE CHECKS AND TESTS.

3.9.3.1 Automatic Transfer Switches

Complete acceptance checks and tests

3.9.4 Preliminary Operations

The start-up engineer must conduct manufacturer recommended start-up procedures and tests to verify that the engine-generator set and auxiliary equipment are ready for functional acceptance tests. Give the Contracting Officer 15 days' advance notice that preliminary operations will be conducted. After preliminary operation has been successfully conducted, the start-up engineer will notify the Contracting Officer in writing stating the engine-generator set and auxiliary equipment are ready for functional acceptance tests.

3.9.5 Preliminary Assembled Operation and Maintenance Manuals

Preliminary assembled operation and maintenance manuals must have been submitted to and approved by the Contracting Officer. Manuals must be prepared as specified in the paragraph ASSEMBLED OPERATION AND MAINTENANCE MANUALS.

3.9.6 Functional Acceptance Test Procedure

Test procedure must be prepared by the start-up engineer specifically for the engine-generator set and auxiliary equipment. The test agenda must cover the requirements specified in the paragraph FUNCTIONAL ACCEPTANCE TESTS. The test procedure must indicate in detail how tests are to be conducted. A statement of the tests that are to be performed without indicating how the tests are to be performed is not acceptable. Indicate what work is planned on each workday and identify the calendar dates of the planned workdays. Specify what additional technical support personnel is needed such as factory representatives for major equipment. Specify on which testing workday each technical support personnel is needed. Data recording forms to be used to document test results are to be submitted with the proposed test procedure. A list of test equipment and instruments must also be included in the test procedure.

3.9.7 Test Equipment

Test equipment and instruments must be on hand prior to scheduling field tests or, subject to Contracting Officer approval, evidence must be provided to show that arrangements have been made to have the necessary equipment and instruments on-site prior to field testing.

3.10 FIELD QUALITY CONTROL

Give Contracting Officer 30 days' notice of dates and times scheduled for tests which require the presence of the Contracting Officer. The Contracting Officer will coordinate with the using activity and schedule a time that will eliminate or minimize interruptions and interference with the activity operations. The Contractor must be responsible for costs associated with conducting tests outside of normal working hours and with incorporating special arrangements and procedures, including temporary power conditions. The Contractor must provide labor, equipment, fuel, test load, and consumables required for the specified tests. The test load must be a cataloged product. Calibration of measuring devices and indicating devices must be certified. Refer to Section 26 20 00 INTERIOR

DISTRIBUTION SYSTEM, for requirements for a cataloged product. Perform the following field tests.

3.10.1 Acceptance Checks and Tests

Perform in accordance with the manufacturer's recommendations, and include the following visual and mechanical inspections and electrical tests, performed in accordance with **NETA ATS**.

3.10.1.1 Circuit Breakers - Low Voltage Insulated Case/Molded Case

a. Visual and Mechanical Inspection

- (1) Compare nameplate data with specifications and approved shop drawings.
- (2) Inspect circuit breaker for correct mounting.
- (3) Operate circuit breaker to ensure smooth operation.
- (4) Inspect case for cracks or other defects.
- (5) Verify tightness of accessible bolted connections and cable connections by calibrated torque-wrench method. Thermo-graphic survey is not required.
- (6) Inspect mechanism contacts and arc chutes in unsealed units.

b. Electrical Tests

- (1) Perform contact-resistance tests.
- (2) Perform insulation-resistance tests.
- (3) Adjust breaker(s) for final settings in accordance with engine-generator set manufacturer's requirements.

3.10.1.2 Current Transformers

a. Visual and Mechanical Inspection

- (1) Compare equipment nameplate data with specifications and approved shop drawings.
- (2) Inspect physical and mechanical condition.
- (3) Verify correct connection.
- (4) Verify that adequate clearances exist between primary and secondary circuit.
- (5) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method. Thermo-graphic survey is not required.
- (6) Verify that all required grounding and shorting connections provide good contact.

b. Electrical Tests

- (1) Perform insulation-resistance tests.
- (2) Perform polarity tests.
- (3) Perform ratio-verification tests.

3.10.1.3 Metering and Instrumentation

a. Visual and Mechanical Inspection

- (1) Compare equipment nameplate data with specifications and approved shop drawings.
- (2) Inspect physical and mechanical condition.
- (3) Verify tightness of electrical connections.

b. Electrical Tests

- (1) Determine accuracy of meters at 25, 50, 75, and 100 percent of full scale.
- (2) Calibrate watt-hour meters according to manufacturer's published data.
- (3) Verify all instrument multipliers.
- (4) Electrically confirm that current transformer secondary circuits are intact.

3.10.1.4 Battery Systems

a. Visual and Mechanical Inspection

- (1) Compare equipment nameplate data with specifications and approved shop drawings.
- (2) Inspect physical and mechanical condition.
- (3) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method. Thermo-graphic survey is not required.
- (4) Measure electrolyte specific gravity and temperature and visually check fill level.
- (5) Verify adequacy of battery support racks, mounting, anchorage, and clearances.

b. Electrical Tests

- (1) Set charger float and equalizing voltage levels.
- (2) Verify all charger functions and alarms.
- (3) Measure each cell voltage and total battery voltage with charger energized and in float mode of operation.

- (4) Perform a capacity load test.

3.10.1.5 Engine-Generator Set

a. Visual and Mechanical Inspection

- (1) Compare equipment nameplate data with specifications and approved shop drawings.
- (2) Inspect physical and mechanical condition.
- (3) Inspect for correct anchorage and grounding.

b. Electrical and Mechanical Tests

- (1) Perform an insulation-resistance test on generator winding with respect to ground. Calculate polarization index.
- (2) Perform phase rotation test to determine compatibility with load requirements.

3.10.1.6 Grounding System

a. Visual and Mechanical Inspection

- (1) Inspect ground system for compliance with contract plans and specifications.

b. Electrical Tests

- (1) Perform ground-impedance measurements utilizing the fall-of-potential method defined in **IEEE 81**. On systems consisting of interconnected ground rods, perform tests after interconnections are complete. Take measurements in normally dry weather, not less than 48 hours after rainfall. Provide site diagram indicating location of test probes with associated distances, and provide a plot of resistance vs. distance.

3.10.2 Functional Acceptance Tests

The tests must be performed by the start-up engineer. Upon successful test completion, the start-up engineer must provide the Contracting Officer with a written test report within 15 calendar days showing the tests performed and the results of each test. The report must include the completed approved test data forms and certification from the start-up engineer that the test results fall within the manufacturer's recommended limits and meet the specified requirements performance. The report must be dated and signed by the start-up engineer, and submitted for approval by the Contracting Officer. The Contracting Officer will witness final acceptance tests. Testing must include, but not be limited to, the following:

- a. Verify proper functioning of each engine protective shutdown device and pre-shutdown alarm device. Testing of the devices must be accomplished by simulating device actuation and observing proper alarm and engine shutdown operation.
- b. Verify proper functioning of the engine over-speed trip device. Testing of the over-speed trip device must be accomplished by raising

the speed of the engine-generator set until an over-speed trip is experienced.

- c. Verify proper functioning of the crank cycle/terminate relay. Testing of the relay must be accomplished by engaging the starter motor with the engine being prevented from running. Observe the complete crank/rest cycle as described in the paragraph STARTING SYSTEM.
- d. Verify proper functioning of the following automatic and manual operations. Testing must include, but not be limited to, the following:
 - (1) Loss of Utility: Initiate a normal power failure with connected test load of rated kW at 1.0 power factor. Record time delay on start, cranking time until engine starts and runs, time to come up to operating speed, voltage and frequency overshoot, and time to achieve steady state conditions with all switches transferred to emergency position.
 - (2) Return of Utility: Return normal power and record time delay on retransfer for each automatic transfer switch, and time delay on engine cool-down and shutdown.
 - (3) Manual starting.
 - (4) Emergency stop.
- e. Operate the engine-generator set at rated current (amperes) until the jacket water temperature stabilizes. Stabilization will be considered to have occurred when three consecutive temperature readings remain unchanged. Continue to operate the generator set for an additional 2 hours. Record instrument readings for terminal voltage, line current, frequency (Hz), engine speed rpm, lubricating oil pressure, jacket water temperature, and ambient temperature at 5 minute intervals for first 15 minutes and at 15 minute intervals thereafter.

3.11 DEMONSTRATION

Upon completion of the work and at a time approved by the Contracting Officer, the Contractor must provide instructions by a qualified instructor to the Government personnel in the proper operation and maintenance of the equipment. All Government personnel responsible for maintenance and operation of each generator set must receive training comparable to the equipment manufacturer's factory training. The duration of instruction must be for not less than one 8 hour working day for instruction of operating personnel and not less than one 8 hour working day for instruction of maintenance personnel.

3.11.1 Instructor's Qualification Resume

Instructors must be regular employees of the engine-generator set manufacturer. The instruction personnel provided to satisfy the requirements above must be factory certified by the related equipment manufacturer to provide instruction services. Submit the name and qualification resume of instructor to the Contracting Officer for approval.

3.11.2 Training Plan

Submit training plan 30 calendar days prior to training sessions.

Training plan must include scheduling, content, outline, and training material (handouts). Content must include, but not be limited to, the following:

3.11.2.1 Operating Personnel Training

This instruction includes operating the engine-generator set, auxiliary equipment including automatic transfer switches in all modes, and the use of all functions and features specified.

3.11.2.2 Maintenance Personnel Training

Training must include mechanical, hydraulic, electrical, and electronic instructions for the engine-generator set and auxiliary equipment including automatic transfer switches.

a. Mechanical Training: Must include at least the following:

- (1) A review of mechanical diagrams and drawings.
- (2) Component location and functions.
- (3) Troubleshooting procedures and techniques.
- (4) Repair procedures.
- (5) Assembly/disassembly procedures.
- (6) Adjustments (how, when, and where).
- (7) Preventive maintenance procedures.
- (8) Review of flow diagram.
- (9) Valve locations and function.
- (10) Valve and hydraulic equipment adjustment and maintenance procedures.
- (11) Hydraulic system maintenance and servicing.
- (12) Lubrication points, type, and recommended procedures and frequency.

b. Electrical and Electronic Maintenance Training: Must include at least the following:

- (1) A review of electrical and electronic systems including wiring diagrams and drawings.
- (2) Troubleshooting procedures for the machine and control systems.
- (3) Electrical and electronic equipment servicing and care.
- (4) Use of diagnostics to locate the causes of malfunction.
- (5) Procedures for adjustments (locating components, adjustments to be made, values to be measured, and equipment required for making adjustments).

- (6) Maintenance and troubleshooting procedures for microprocessor or minicomputer where applicable.
- (7) Circuit board repair procedures where applicable (with schematics provided).
- (8) Use of diagnostic tapes.
- (9) Recommended maintenance servicing and repair for motors, switches, relays, solenoids, and other auxiliary equipment and devices.

3.12 ONSITE TRAINING

Conduct a training course for the operating staff as designated by the Contracting Officer. The training period must consist of a total 16 hours of normal working time and must start after the system is functionally completed but prior to final acceptance.

- a. Submit a letter giving the date proposed for conducting the onsite training course, the agenda of instruction, a description of the digital video recording to be provided. The course instructions must cover pertinent points involved in operating, starting, stopping, servicing the equipment, as well as major elements of the operation and maintenance manuals. Additionally, the course instructions must demonstrate routine maintenance procedures as described in the operation and maintenance manuals.
- b. Submit a digital video recording of the entire training session.
- c. One full size reproducible Mylar ach drawing must accompany the booklets. Mylars must be rolled and placed in a heavy cardboard tube with threaded caps on each end. The manual must include step-by-step procedures for system startup, operation, and shutdown; drawings, diagrams, and single-line schematics to illustrate and define the electrical, mechanical, and hydraulic systems together with their controls, alarms, and safety systems; the manufacturer's name, model number, and a description of equipment in the system. The instructions must include procedures for interface and interaction with related systems to include automatic transfer switches. Each booklet must include a CD containing an ASCII file of the procedures.
- d. Provide approved operation and maintenance manuals for the training course. Post approved instructions prior to the beginning date of the training course. Coordinate the training course schedule with the using service's work schedule, and submit for approval 14 days prior to beginning date of proposed beginning date of training.

3.13 INSTALLATION

Installation must conform to the applicable requirements of IEEE C2, NFPA 30, NFPA 37, and NFPA 70.

3.14 FINAL TESTING AND INSPECTION

- a. Start the engine, record the starting time, make and record all engine manufacturer's after-starting checks and inspections during a reasonable warm-up period.

- b. Increase the load in steps no greater than the Maximum Step Load Increase to 100 percent of Service Load, and operate the engine-generator set for at least 30 minutes. Measure the vibration at the end bearings (front and back of engine, outboard end of generator) in the horizontal, vertical, and axial directions. Verify that the vibration is within the same range as previous measurements and is within the required range.
- c. Remove load and shut down the engine-generator set after the recommended cool down period.
- d. Remove the lube oil filter and have the oil and filter examined by the engine manufacturer for excessive metal, abrasive foreign particles, etc. Verify any corrective action for effectiveness by running the engine for 8 hours at Service Load, then re-examine the oil and filter.
- e. Remove the fuel filter and examine the filter for trash, abrasive foreign particles, etc.
- f. Visually inspect and check engine and generator mounting bolts for tightness and visible damage.
- g. Replace air, oil, and fuel filters with new filters.

3.15 MANUFACTURER'S FIELD SERVICE

The engine generator-set manufacturer must furnish a qualified representative to supervise the installation of the engine generator-set, assist in the performance of the onsite tests, and instruct personnel as to the operational and maintenance features of the equipment.

3.16 POSTED DATA AND INSTRUCTIONS

Post Data and Instructions prior to field acceptance testing of the engine generator set.

- a. Provide two sets of typed instructions/data in 8-1/2 x 11 inch format, laminated in weatherproof plastic, and placed in three-ring vinyl binders. Place the binders as directed by the Contracting Officer. Provide the instructions prior to acceptance of the engine generator set installation.
- b. Include a one-line diagram, wiring and control diagrams and a complete layout of the system in the first set. Include the condensed operating instructions describing manufacturer's pre-start checklist and precautions; startup procedures for test-mode, manual-start mode, and automatic-start mode (as applicable); running checks, procedures, and precautions; and shutdown procedures, checks, and precautions in the second set. Include procedures for interrelated equipment (such as heat recovery systems, co-generation, load-shedding, and automatic transfer switches).
- c. Submit instructions including: the manufacturers pre-start checklist and precautions; startup procedures for test-mode, manual-start mode, and automatic-start mode (as applicable); running checks, procedures, and precautions; and shutdown procedures, checks, and precautions. Include procedures for interrelated equipment (such as heat recovery systems, co-generation, load-shedding, and automatic transfer switches). Provide weatherproof instructions, laminated in plastic,

and post where directed.

3.17 ACCEPTANCE

Submit drawings which accurately depict the as-built configuration of the installation, upon acceptance of the engine-generator set installation. Revise layout drawings to reflect the as-built conditions and submit them with the as-built drawings. Final acceptance of the engine-generator set will not be given until the Contractor has successfully completed all tests and all defects in installation material or operation have been corrected.

-- End of Section --

SECTION 26 51 00

INTERIOR LIGHTING
05/20, CHG 2: 11/21

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM A580/A580M	(2018) Standard Specification for Stainless Steel Wire
ASTM A641/A641M	(2019) Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire
ASTM A653/A653M	(2020) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A1008/A1008M	(2021a) Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable
ASTM B164	(2003; R 2014) Standard Specification for Nickel-Copper Alloy Rod, Bar, and Wire
ASTM B633	(2019) Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel

EUROPEAN UNION (EU)

Directive 2011/65/EU	(2011) Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment

ILLUMINATING ENGINEERING SOCIETY (IES)

ANSI/IES LM-79	(2019) Approved Method: Electrical and Photometric Measurements of Solid State Lighting Products
ANSI/IES LM-80	(2020) Approved Method: Measuring Luminous Flux and Color Maintenance of LED Packages, Arrays and Modules
ANSI/IES LS-1	(2020) Lighting Science: Nomenclature and Definitions for Illuminating Engineering

ANSI/IES TM-15	(2020) Technical Memorandum: Luminaire Classification System for Outdoor Luminaires
ANSI/IES TM-21	(2021) Technical Memorandum: Projecting Long-Term Luminous, Photon, and Radiant Flux Maintenance of LED Light Sources
IES Lighting Library	IES Lighting Library
INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)	
IEEE 100	(2000; Archived) The Authoritative Dictionary of IEEE Standards Terms
IEEE C2	(2017; Errata 1-2 2017; INT 1 2017) National Electrical Safety Code
NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)	
ANSI C78.54	(2019) Specification Sheet for Tubular Fluorescent Replacement and Retrofit LED Lamps
NEMA 250	(2020) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA ANSLG C78.377	(2017) Electric Lamps— Specifications for the Chromaticity of Solid State Lighting Products
NEMA C82.77-10	(2020) Harmonic Emission Limits - Related Power Quality Requirements
NEMA SSL 1	(2016) Electronic Drivers for LED Devices, Arrays, or Systems
NEMA SSL 3	(2011) High-Power White LED Binning for General Illumination
NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)	
NFPA 70	(2020; ERTA 20-1 2020; ERTA 20-2 2020; ERTA 20-3 2020; TIA 20-1; TIA 20-2; TIA 20-3; TIA 20-4; TIA 20-5; TIA 20-6; TIA 20-7; TIA 20-8; TIA 20-9; TIA 20-10; TIA 20-11; TIA 20-12; TIA 20-13; TIA 20-14; TIA 20-15; TIA 20-16; ERTA 20-4 2022) National Electrical Code
NFPA 101	(2021) Life Safety Code
U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)	
47 CFR 15	Radio Frequency Devices
UNDERWRITERS LABORATORIES (UL)	
UL 924	(2016; Reprint May 2020) UL Standard for

Safety Emergency Lighting and Power
Equipment

UL 1598	(2021; Reprint Jun 2021) Luminaires
UL 1598C	(2014) Standard for Light-Emitting Diode (LED) Retrofit Luminaire Conversion Kits
UL 1993	(2017) Self-Ballasted Lamps and Lamp Adapters
UL 8750	(2015; Reprint Sep 2021) UL Standard for Safety Light Emitting Diode (LED) Equipment for Use in Lighting Products

1.2 RELATED REQUIREMENTS

Materials not considered to be luminaires, luminaire accessories, or lighting equipment are specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

1.3 DEFINITIONS

- a. Unless otherwise specified or indicated, electrical and electronics terms used in these specifications and on the drawings, must be as defined in IEEE 100 and ANSI/IES LS-1.
- b. For LED luminaire light sources, "Useful Life" is the operating hours before reaching 70 percent of the initial rated lumen output (L70) with no catastrophic failures under normal operating conditions. This is also known as 70 percent "Rated Lumen Maintenance Life" as defined in ANSI/IES LM-80.
- c. For LED luminaires, "Luminaire Efficacy" (LE) is the appropriate measure of energy efficiency, measured in lumens/watt. This is gathered from LM-79 data for the luminaire, in which absolute photometry is used to measure the lumen output of the luminaire as one entity, not the source separately and then the source and housing together.
- d. Total harmonic distortion (THD) is the root mean square (RMS) of all the harmonic components divided by the total fundamental current.

1.4 SUBMITTALS

Government approval is required for submittals. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Luminaire Drawings

SD-03 Product Data

Luminaires

Light Sources

LED Drivers

Luminaire Warranty

Exit Signs

Emergency Drivers

Linear LED Lamps

Luminaire Design Data

SD-07 Certificates

LED Driver and Dimming Switch Compatibility Certificate

SD-10 Operation and Maintenance Data

Lighting System, Data Package 5

Maintenance Staff Training Plan

End-User Training Plan

1.5 QUALITY ASSURANCE

Data, drawings, and reports must employ the terminology, classifications and methods prescribed by the **IES Lighting Library** as applicable, for the lighting system specified.

1.5.1 Luminaire Drawings

Include dimensions, accessories installation details, and construction details. Photometric data, including CRI, CCT, LED driver type, zonal lumen data, and candlepower distribution data must accompany shop drawings.

1.5.2 Luminaire Design Data

- a. Provide safety certification and file number for the luminaire family that must be listed, labeled, or identified in accordance with the **NFPA 70**. Applicable testing bodies are determined by the US Occupational Safety Health Administration (OSHA) as Nationally Recognized Testing Laboratories (NRTL) and include: CSA (Canadian Standards Association), ETL (Edison Testing Laboratory), and UL (Underwriters Laboratories).
- b. Provide long term lumen maintenance projections for each LED luminaire in accordance with **ANSI/IES TM-21**. Data used for projections must be obtained from testing in accordance with **ANSI/IES LM-80**.

1.5.3 LED Driver and Dimming Switch Compatibility Certificate

Submit certification from the luminaire, driver, or dimmer switch manufacturer that ensures compatibility and operability between devices without flickering and to specified dimming levels.

1.5.4 Test Laboratories

Test laboratories for the **ANSI/IES LM-79** and **ANSI/IES LM-80** test reports must be one of the following:

- a. National Voluntary Laboratory Accreditation Program (NVLAP) accredited for solid-state lighting testing as part of the Energy-Efficient Lighting Products laboratory accreditation program for both LM-79 and LM-80 testing.
- b. One of the qualified labs listed on the Department of Energy - LED Lighting Facts Approved Testing Laboratories List for LM-79 testing.
- c. One of the EPA-Recognized Laboratories listed for LM-80 testing.

1.5.5 Regulatory Requirements

Equipment, materials, installation, and workmanship must be in accordance with the mandatory and advisory provisions of NFPA 70, unless more stringent requirements are specified or indicated. Provide luminaires and assembled components that are approved by and bear the label of UL for the applicable location and conditions unless otherwise specified.

1.5.6 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design, and workmanship. Products must have been in satisfactory commercial or industrial use for six months prior to bid opening. The six-month period must include applications of equipment and materials under similar circumstances and of similar size. The product must have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the six-month period. Where two or more items of the same class of equipment are required, these items must be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

1.5.6.1 Alternative Qualifications

Products having less than a six-month field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

1.5.6.2 Material and Equipment Manufacturing Date

Do not use products manufactured more than six months prior to date of delivery to site, unless specified otherwise.

1.6 WARRANTY

Support all equipment items by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

1.6.1 Luminaire Warranty

Provide and transfer to the government the original LED luminaire manufacturers standard commercial warranty for each different luminaire manufacturer used in the project.

- a. Provide a written five year minimum replacement warranty for material, luminaire finish, and workmanship. Provide written warranty document that contains all warranty processing information needed, including customer service point of contact, whether or not a return authorization number is required, return shipping information, and closest return location to the luminaire location.

(1) Finish warranty must include failure and substantial deterioration such as blistering, cracking, peeling, chalking, or fading.

(2) Material warranty must include:

(a) All LED drivers and integral control equipment.

(b) Replacement when more than 15 percent of LED sources in any lightbar or subassembly(s) are defective, non-starting, or operating below 70 percent of specified lumen output.

- b. Warranty period must begin in accordance with the manufacturer's standard warranty starting date.
- c. Provide replacements that are promptly shipped, without charge, to the using Government facility point of contact and that are identical to or an improvement upon the original equipment. All replacements must include testing of new components and assembly.

1.7 OPERATION AND MAINTENANCE MANUALS

1.7.1 Lighting System

Provide operation and maintenance manuals for the lighting system in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA that provide basic data relating to the design, operation, and maintenance of the lighting system for the building. Include the following:

- a. Manufacturers' operating and maintenance manuals.
- b. Luminaire shop drawings for modified and custom luminaires.
- c. Luminaire Manufacturers' standard commercial warranty information as specified in paragraph LUMINAIRE WARRANTY.

PART 2 PRODUCTS

2.1 PRODUCT COORDINATION

2.2 LUMINAIRES

UL 1598, NEMA C82.77-10. Provide luminaires as indicated in the luminaire schedule and NL plates or details on project plans, complete with light source, wattage, and lumen output indicated. All luminaires of the same type must be provided by the same manufacturer. Luminaires must be specifically designed for use with the driver and light source provided.

2.2.1 Luminaires

UL 8750, ANSI/IES LM-79, ANSI/IES LM-80. For all luminaires, provide:

- a. Complete system with LED drivers and light sources.

- b. Housings constructed of non-corrosive materials. All new aluminum housings must be anodized or powder-coated. All new steel housings must be treated to be corrosion resistant.
- c. **ANSI/IES TM-21, ANSI/IES LM-80**. Minimum L70 lumen maintenance value of 50,000 hours unless otherwise indicated in the luminaire schedule. Luminaire drive current value must be identical to that provided by test data for luminaire in question.
- d. Minimum efficacy as specified in the luminaire schedule. Theoretical models of initial lamp lumens per watt are not acceptable. If efficacy values are not listed in the luminaire schedule, provide luminaires that meet the following minimum values:

Luminaire Style	Minimum Luminaire Efficacy
Recessed 1 by 4, 2 by 4, and 2 by 2	100 LPW
Recessed Downlight (fixed, adjustable, wallwash)	80 LPW

- e. LED driver and light source package, array, or module are accessible for service or replacement without removal or destruction of luminaire.
- f. Lenses constructed of heat tempered borosilicate glass, UV-resistant acrylic, or silicone. Sandblasting, etching and polishing must be performed as indicated in the luminaire description.
- g. **ANSI/IES TM-15**. Provide exterior building-mounted luminaires that do not ei. For all recessed luminaires that are identified to be in contact with insulation, provide luminaires that are IC-rated.
- h. For all recessed luminaires that are to be installed in air plenums, require housings that are Chicago Plenum rated.

2.2.1.1 Luminaire Conversion Kits

Provide luminaire conversion kits that meet **UL 1598C** Standard for Light-Emitting Diode (LED) Retrofit Luminaire Conversion Kits.

2.3 LIGHT SOURCES

NEMA ANSLG C78.377, NEMA SSL 3. Provide type, delivered lumen output, and wattage as indicated in the luminaire schedule on project plans.

2.3.1 LED Light Sources

CEC Title 20. Provide LED light sources that meet the following requirements:

- a. **NEMA ANSLG C78.377**. Emit white light and have a nominal CCT of 4000 Kelvin.
- b. Minimum Color Rendering Index (CRI) of 90.
- c. **Directive 2011/65/EU**. Restriction of Hazardous Substances (RoHS) compliant.

- d. Light source color consistency by utilizing a binning tolerance within a 3-step McAdam ellipse.

2.3.1.1 Linear LED Lamps

Provide linear LED Lamps that are compatible with existing instant-start or programmed-start ballasts, and meet the following additional requirements:

- a. **UL 1993** UL Type A linear LED lamp.
- b. Power Factor greater than or equal to 0.90 at full input power and across specified dimming range.
- c. Maximum Total Harmonic Distortion (THD) less than or equal to 20 percent at full input power and across specified dimming range.
- d. Lumen per watt efficacy no less than 120.
- e. Minimum beam angle of 180 degrees.
- f. Lamp datasheet complies with **ANSI C78.54**. Manufacturer must provide list of all ballasts that are compatible for use with lamp.

2.4 LED DRIVERS

NEMA SSL 1, UL 8750. Provide LED drivers that are electronic, UL Class 1 or Class 2, constant-current type and that comply with the following requirements:

- a. The combined driver and LED light source system does not exceed the minimum luminaire efficacy values as listed in the luminaire schedule provided.
- b. Operates at a voltage of 120-277 volts at 50/60 hertz, with input voltage fluctuations of plus/minus 10 percent.
- c. Power Factor (PF) greater than or equal to 0.90 at full input power and across specified dimming range.
- d. Maximum Total Harmonic Distortion (THD) less than 20 percent at full input power and across specified dimming range.
- e. Operates for at least 50,000 hours at maximum case temperature and 90 percent non-condensing relative humidity.
- f. Withstands Category A surges of 2 kV without impairment of performance. Provide surge protection that is integral to the driver.
- g. Integral thermal protection that reduces the output power to protect the driver and light source from damage if the case temperature approaches or exceeds the driver's maximum operating temperature.
- h. **47 CFR 15**. Complies with the requirements of the Federal Communications Commission (FCC) rules and regulations, Non-Consumer (Class A) for EMI/RFI (conducted and radiated).
- i. Class A sound rating.

2.5 EXIT AND EMERGENCY LIGHTING EQUIPMENT

2.5.1 Exit Signs

UL 924, NFPA 101. Provide wattage as indicated in the luminaire schedule on project plans. Provide LED Exit Signs that meet the following criteria:

- a. Housing constructed of UV-stable, thermo-plastic.
- b. UL listed for damp location.
- c. Configured for universal mounting.
- d. 6 inch high, 3/4 inch stroke green lettering on face of sign with chevrons on either side of lettering to indicate direction.
- e. Single or double face as indicated in project plans and luminaire schedule.

2.5.1.1 Exit Signs with Battery Backup

Equip with automatic power failure device, test switch, and pilot light, and fully automatic high/low trickle charger in a self-contained power pack. Battery must be sealed, maintenance free nickel-cadmium type, and must operate unattended for a period of not less than five years. Emergency run time must be a minimum of 1-1/2 hours. LEDs must have a minimum rated life of 10 years. Provide self-diagnostic circuitry integral to emergency LED driver.

2.5.2 Emergency Lighting Unit (ELU)

UL 924, NFPA 101. Provide emergency lighting units (ELUs) completely assembled with wiring and mounting devices, ready for installation at the locations indicated. Provide in UV-stable, thermo-plastic housing with UL damp label as indicated. Emergency lighting units must be rated for 12 volts, except units having no remote-mounted light sources and having no more than two unit-mounted light sources may be rated six volts. Equip units with brown-out sensitive circuit to activate battery when input voltage falls to 75 percent of normal. Equip with two LED light sources, automatic power failure device, test switch, and pilot light, and fully automatic high/low trickle charger in a self-contained power pack. Battery must be sealed, maintenance free lead-calcium type, and must operate unattended for a period of not less than five years. Emergency run time must be a minimum of 90 minutes. LEDs must have a minimum rated life of 10 years. Provide self-diagnostic circuitry integral to emergency LED driver.

2.5.3 LED Emergency Drivers

UL 924, NFPA 101. Provide LED emergency driver with automatic power failure detection, test switch and LED indicator (or combination switch/indicator) located on luminaire exterior, and fully-automatic solid-state charger, battery and inverter integral to a self-contained housing. Provide self-diagnostic function integral to emergency driver. Integral nickel-cadmium/lead-calcium battery is required to supply a minimum of 90 minutes of emergency power at 10 watts, 10-50 VDC compatible with LED forward voltage requirements, constant output. Driver must be RoHS compliant, rated for installation in plenum-rated spaces and damp

locations, and be warranted for a minimum of five years.

2.5.4 Self-Diagnostic Circuitry for LED Drivers

UL 924, NFPA 101. Provide emergency lighting unit with fully-automatic, integral self-testing/diagnostic electronic circuitry. Circuitry must provide for a one minute diagnostic test every 28 days, and a 30 minute diagnostic test every six months, minimum. Any malfunction of the unit must be indicated by LED(s) visible from the exterior of the luminaire. A manual test switch must also be provided to perform a diagnostic test at any given time.

2.6 LUMINAIRE MOUNTING ACCESSORIES

2.6.1 Recess and Surface Mounted Luminaires

Provide access to light source and LED driver from bottom of luminaire. Provide trim and lenses for the exposed surface of flush-mounted luminaires as indicated on project drawings and specifications. Luminaires recessed in ceilings which have a fire resistive rating of one hour or more must be enclosed in a box which has a fire resistive rating equal to that of the ceiling. For surface mounted luminaires with brackets, provide flanged metal stem attached to outlet box, with threaded end suitable for supporting the luminaire rigidly in design position. Flanged part of luminaire stud must be of broad base type, secured to outlet box at not fewer than three points.

2.6.2 Luminaire Support Hardware

2.6.2.1 Wire

ASTM A641/A641M. Galvanized, soft tempered steel, minimum **0.11 inches** in diameter, or galvanized, braided steel, minimum **0.08 inches** in diameter.

2.6.2.2 Wire for Humid Spaces

ASTM A580/A580M. Composition 302 or 304, annealed stainless steel, minimum **0.11 inches** in diameter.

ASTM B164. UNS N04400, annealed nickel-copper alloy, minimum **0.11 inches** in diameter.

2.6.2.3 Threaded Rods

Threaded steel rods, **3/16 inch** diameter, zinc or cadmium coated.

2.6.2.4 Straps

Galvanized steel, **one by 3/16 inch**, conforming to **ASTM A653/A653M**, with a light commercial zinc coating or **ASTM A1008/A1008M** with an electrodeposited zinc coating conforming to **ASTM B633**, Type RS.

2.7 EQUIPMENT IDENTIFICATION

2.7.1 Manufacturer's Nameplate

Each item of equipment must have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be

acceptable.

2.7.2 Labels

UL 1598. All luminaires must be clearly marked for operation of specific light sources and LED drivers. The labels must be easy to read when standing next to the equipment, and durable to match the life of the equipment to which they are attached. Note the following light source characteristics in the format "Use Only ____":

- a. Correlated Color Temperature (CCT) and Color Rendering Index (CRI) for all luminaires.
- b. Driver and dimming protocol.

All markings related to light source type must be clear and located to be readily visible to service personnel, but unseen from normal viewing angles when light sources are in place. LED drivers must have clear markings indicating dimming type and indicate proper terminals for the various outputs.

2.8 FACTORY APPLIED FINISH

NEMA 250. Provide all luminaires and lighting equipment with factory-applied painting system that as a minimum, meets requirements of corrosion-resistance testing.

PART 3 EXECUTION

3.1 INSTALLATION

IEEE C2, NFPA 70.

3.1.1 Light Sources

When light sources are not provided as an integral part of the luminaire, deliver light sources of the type, wattage, lumen output, color temperature (CCT), color rendering index (CRI), and voltage rating indicated to the project site and install just prior to project completion, if not already installed in the luminaires from the factory.

3.1.2 Luminaires

Set luminaires plumb, square, and level with ceiling and walls, in alignment with adjacent luminaires and secure in accordance with manufacturers' directions and approved drawings. Provide accessories as required for ceiling construction type indicated on Finish Schedule. Luminaire catalog numbers do not necessarily denote specific mounting accessories for type of ceiling in which a luminaire may be installed. Provide wires, straps, or rods for luminaire support in this section. Install luminaires with vent holes free of air blocking obstacles.

3.1.2.1 Recessed and Semi-Recessed Luminaires

- a. Support recessed and semi-recessed luminaires independently from the building structure by a minimum of two wires, straps or rods per luminaire and located near opposite corners of the luminaire. Secure horizontal movement with clips provided by manufacturer. Ceiling grid clips are not allowed as an alternative to independently supported

luminaires.

- b. Support round luminaires or luminaires smaller in size than the ceiling grid independently from the building structure by a minimum of four wires, straps or rods per luminaire, spaced approximately equidistant around.
- c. Do not support luminaires by acoustical tile ceiling panels.
- d. Where luminaires of sizes less than the ceiling grid are indicated to be centered in the acoustical panel, support each independently and provide at least two $\frac{3}{4}$ inch metal channels spanning, and secured to, the ceiling tees for centering and aligning the luminaire.
- e. Adjust aperture rings on all applicable ceiling recessed luminaires to accommodate various ceiling material thickness. Coordinate cut-out size in ceiling to ensure aperture covers cut-out entirely. Install aperture rings such that the bottom of the ring is flush with finished ceiling or not more than $\frac{1}{16}$ inch above. Do not install luminaires such that the aperture ring extends below the finished ceiling surface.

3.1.3 LED Drivers

Provide LED drivers integral to luminaire as constructed by the manufacturer.

3.1.4 Exit Signs

NFPA 101. Wire exit signs and emergency lighting units ahead of the local switch, to the normal lighting circuit located in the same room or area.

Connect exit signs on separate circuits and serve from **existing circuit previously serving exit signs**. Provide only one source of control, which would be the circuit breaker in the emergency panel. Paint source of control red and provide lockout capability.

3.2 FIELD QUALITY CONTROL

3.2.1 Tests

3.2.1.1 Emergency Lighting Test

Interrupt power supply to demonstrate proper operation of emergency lighting. If adjustments are made to the lighting system, re-test system to show compliance with standards.

3.3 CLOSEOUT ACTIVITIES

3.3.1 Training

3.3.1.1 Maintenance Staff Training

Submit a **Maintenance Staff Training Plan** at least 30 calendar days prior to training session that describes training procedures for Owner's personnel in the operation and maintenance of lighting and lighting control system. Provide on-site training which demonstrates full system functionality, assigning schedules, calibration adjustments for light levels and sensor sensitivity, integration procedures for connecting to third-party devices, and manual override including information on

appropriate use. Provide protocols for troubleshooting, maintenance, repair, and replacement, and literature on available system updates and process for implementing updates.

3.3.1.2 End-User Training

Submit an [End-User Training Plan](#) at least 30 calendar days prior to training session that describes training procedures for end-users on the lighting control system. Provide users with a list of control devices located within user-occupied spaces, such as photosensors and occupancy and vacancy sensors, including information on the proper operation and schedule for each device. Provide demonstration for each type of interface. Provide users with the building schedule as currently commissioned, including conditional programming based on astronomic time clock functionality. Provide users with the correct contact information for maintenance personnel who will be available to address any lighting control issues.

Provide laminated instructions to the user at each scene wallstation. Provide only instructions relevant to the functionality of the specific scene wallstation. Provide a description of each labeled scene control button. If the room utilizes occupancy/vacancy sensors or photosensors, include a description of this functionality on the instruction sheet.

-- End of Section --

SECTION 27 10 00

BUILDING TELECOMMUNICATIONS CABLING SYSTEM
08/11

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D709 (2017) Standard Specification for
Laminated Thermosetting Materials

ELECTRONIC COMPONENTS INDUSTRY ASSOCIATION (ECIA)

ECIA EIA/ECA 310-E (2005) Cabinets, Racks, Panels, and
Associated Equipment

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 100 (2000; Archived) The Authoritative
Dictionary of IEEE Standards Terms

INSULATED CABLE ENGINEERS ASSOCIATION (ICEA)

ICEA S-83-596 (2021) Indoor Optical Cable

ICEA S-90-661 (2021) Category 3 and 5E Individually
Unshielded Twisted Pairs, Indoor Cables
(With or Without an Overall Shield) for
Use in General Purpose and LAN
Communications Wiring Systems

NATIONAL ELECTRICAL CONTRACTORS ASSOCIATION (NECA)

NECA/BICSI 568 (2006) Standard for Installing Building
Telecommunications Cabling

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI/NEMA WC 66 (2019) Performance Standard for Category 6
and Category 7 100 Ohm Shielded and
Unshielded Twisted Pairs

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (2020; ERTA 20-1 2020; ERTA 20-2 2020;
ERTA 20-3 2020; TIA 20-1; TIA 20-2; TIA
20-3; TIA 20-4; TIA 20-5; TIA 20-6; TIA
20-7; TIA 20-8; TIA 20-9; TIA 20-10; TIA
20-11; TIA 20-12; TIA 20-13; TIA 20-14;
TIA 20-15; TIA 20-16; ERTA 20-4 2022)
National Electrical Code

TELECOMMUNICATIONS INDUSTRY ASSOCIATION (TIA)

TIA-455-21	(1988a; R 2012) FOTP-21 - Mating Durability of Fiber Optic Interconnecting Devices
TIA-526-7	(2015a; R 2022) Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant, Adoption of IEC 61280-4-2 edition 2: Fibre-Optic Communications Subsystem Test Procedures - Part 4-2: Installed Cable Plant - Single-Mode Attenuation and Optical Return Loss Measurement
TIA-526-14	(2015c) OFSTP-14A Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant
TIA-568.0	(2020e) Generic Telecommunications Cabling for Customer Premises
TIA-568.1	(2020e) Commercial Building Telecommunications Infrastructure Standard
TIA-568.2	(2018d) Balanced Twisted-Pair Telecommunications Cabling and Components Standards
TIA-568.3	(2016d; Add 1 2019) Optical Fiber Cabling Components Standard
TIA-569	(2019e) Telecommunications Pathways and Spaces
TIA-606	(2021d) Administration Standard for Telecommunications Infrastructure
TIA-607	(2019d) Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises
TIA-1152	(2016; R 2021) Requirements for Field Test Instruments and Measurements for Balanced Twisted-Pair Cabling
TIA/EIA-604-10	(2002a) FOCIS 10 Fiber Optic Connector Intermateability Standard - Type LC

U.S. FEDERAL COMMUNICATIONS COMMISSION (FCC)

FCC Part 68	Connection of Terminal Equipment to the Telephone Network (47 CFR 68)

UNDERWRITERS LABORATORIES (UL)

UL 50	(2015) UL Standard for Safety Enclosures for Electrical Equipment,

Non-Environmental Considerations

UL 444	(2017; Reprint Jun 2021) UL Standard for Safety Communications Cables
UL 467	(2022) UL Standard for Safety Grounding and Bonding Equipment
UL 514C	(2014; Reprint Feb 2020) UL Standard for Safety Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers
UL 723	(2018) UL Standard for Safety Test for Surface Burning Characteristics of Building Materials
UL 969	(2017; Reprint Mar 2018) UL Standard for Safety Marking and Labeling Systems
UL 1286	(2008; Reprint Apr 2021) UL Standard for Safety Office Furnishings
UL 1863	(2004; Reprint Oct 2019) UL Standard for Safety Communication Circuit Accessories

1.2 RELATED REQUIREMENTS

Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM apply to this section with additions and modifications specified herein.

1.3 DEFINITIONS

Unless otherwise specified or indicated, electrical and electronics terms used in this specification shall be as defined in TIA-568.1, TIA-568.2, TIA-568.3, TIA-569, TIA-606 and IEEE 100 and herein.

1.3.1 Campus Distributor (CD)

A distributor from which the campus backbone cabling emanates. (International expression for main cross-connect (MC).)

1.3.2 Building Distributor (BD)

A distributor in which the building backbone cables terminate and at which connections to the campus backbone cables may be made. (International expression for intermediate cross-connect (IC).)

1.3.3 Floor Distributor (FD)

A distributor used to connect horizontal cable and cabling subsystems or equipment. (International expression for horizontal cross-connect (HC).)

1.3.4 Telecommunications Room (TR)

An enclosed space for housing telecommunications equipment, cable, terminations, and cross-connects. The room is the recognized cross-connect between the backbone cable and the horizontal cabling.

1.3.5 Entrance Facility (EF) (Telecommunications)

An entrance to the building for both private and public network service cables (including wireless) including the entrance point at the building wall and continuing to the equipment room.

1.3.6 Equipment Room (ER) (Telecommunications)

An environmentally controlled centralized space for telecommunications equipment that serves the occupants of a building. Equipment housed therein is considered distinct from a telecommunications room because of the nature of its complexity.

1.3.7 Open Cable

Cabling that is not run in a raceway as defined by NFPA 70. This refers to cabling that is "open" to the space in which the cable has been installed and is therefore exposed to the environmental conditions associated with that space.

1.3.8 Open Office

A floor space division provided by furniture, moveable partitions, or other means instead of by building walls.

1.3.9 Pathway

A physical infrastructure utilized for the placement and routing of telecommunications cable.

1.4 SYSTEM DESCRIPTION

The building telecommunications cabling and pathway system shall include permanently installed horizontal cabling, horizontal and service entrance facilities, work area pathways, telecommunications outlet assemblies, conduit, raceway, and hardware for splicing, terminating, and interconnecting cabling necessary to transport telephone and data (including LAN) between equipment items in a building. The horizontal system shall be wired in a star topology from the telecommunications work area to the floor distributor or campus distributor at the center or hub of the star. The backbone cabling and pathway system includes intrabuilding and interbuilding interconnecting cabling, pathway, and terminal hardware. The intrabuilding backbone provides connectivity from the floor distributors to the building distributors or to the campus distributor and from the building distributors to the campus distributor as required. The backbone system shall be wired in a star topology with the campus distributor at the center or hub of the star. Provide telecommunications pathway systems referenced herein as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. The telecommunications contractor must coordinate with the NMCI/COSC/NGEN contractor concerning access to and configuration of telecommunications spaces. The telecommunications contractor may be required to coordinate work effort within the telecommunications spaces with the NMCI/COSC/NGEN contractor.

1.5 SUBMITTALS

Government approval is required for submittals. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Telecommunications Drawings

Telecommunications Space Drawings

In addition to Section 01 33 00 SUBMITTAL PROCEDURES, provide shop drawings in accordance with paragraph SHOP DRAWINGS.

Equipment Support Frame

SD-03 Product Data

Telecommunications Cabling (horizontal)

Patch Panels

Telecommunications Outlet/Connector Assemblies

Submittals shall include the manufacturer's name, trade name, place of manufacture, and catalog model or number. Include performance and characteristic curves. Submittals shall also include applicable federal, military, industry, and technical society publication references. Should manufacturer's data require supplemental information for clarification, the supplemental information shall be submitted as specified in paragraph REGULATORY REQUIREMENTS and as required in Section 01 33 00 SUBMITTAL PROCEDURES.

SD-06 Test Reports

Telecommunications Cabling Testing

SD-07 Certificates

Telecommunications Contractor Qualifications

Key Personnel Qualifications

Manufacturer Qualifications

Test Plan

SD-09 Manufacturer's Field Reports

Factory Reel Tests

SD-10 Operation and Maintenance Data

Telecommunications Cabling and Pathway System Data Package 5

SD-11 Closeout Submittals

Record Documentation

1.6 QUALITY ASSURANCE

1.6.1 Shop Drawings

In exception to Section 01 33 00 SUBMITTAL PROCEDURES, submitted plan drawings shall be a minimum of 11 by 17 inches in size using a minimum scale of 1/8 inch per foot, except as specified otherwise. Include wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure a coordinated installation. Wiring diagrams shall identify circuit terminals and indicate the internal wiring for each item of equipment and the interconnection between each item of equipment. Drawings shall indicate adequate clearance for operation, maintenance, and replacement of operating equipment devices. Submittals shall include the nameplate data, size, and capacity. Submittals shall also include applicable federal, military, industry, and technical society publication references.

1.6.1.1 Telecommunications Drawings

Provide drawings in accordance with TIA-606. The identifier for each termination and cable shall appear on the drawings. Drawings shall depict final telecommunications installed wiring system infrastructure in accordance with TIA-606. The drawings should provide details required to prove that the distribution system shall properly support connectivity from the EF telecommunications and ER telecommunications, CD's, BD's, and FD's to the telecommunications work area outlets. Provide a plastic laminated schematic of the as-installed telecommunications cable system showing cabling, CD's, BD's, FD's, and the EF and ER for telecommunications keyed to floor plans by room number. Mount the laminated schematic in the EF telecommunications space as directed by the Contracting Officer. The following drawings shall be provided as a minimum:

- a. T1 - Layout of complete building per floor - Building Area/Serving Zone Boundaries, Backbone Systems, and Horizontal Pathways. Layout of complete building per floor. The drawing indicates location of building areas, serving zones, vertical backbone diagrams, telecommunications rooms, access points, pathways, grounding system, and other systems that need to be viewed from the complete building perspective.
- b. T4 - Typical Detail Drawings - Faceplate Labeling, Firestopping, Americans with Disabilities Act (ADA), Safety, Department of Transportation (DOT). Detailed drawings of symbols and typicals such as faceplate labeling, faceplate types, faceplate population installation procedures, detail racking, and raceways.

1.6.1.2 Telecommunications Space Drawings

Provide T3 drawings in accordance with TIA-606 that include telecommunications rooms plan views, pathway layout (cable tray, racks, ladder-racks, etc.), mechanical/electrical layout, and cabinet, backboard and wall elevations. Drawings shall show layout of applicable equipment including incoming cable stub or connector blocks, building protector assembly, outgoing cable connector blocks, patch panels and equipment spaces and cabinet/racks. Drawings shall include a complete list of equipment and material, equipment rack details, proposed layout and anchorage of equipment and appurtenances, and equipment relationship to

other parts of the work including clearance for maintenance and operation. Drawings may also be an enlargement of a congested area of T1 or T2 drawings.

1.6.2 Telecommunications Qualifications

Work under this section shall be performed by and the equipment shall be provided by the approved telecommunications contractor and key personnel. Qualifications shall be provided for: the telecommunications system contractor, the telecommunications system installer, and the supervisor (if different from the installer). A minimum of 30 days prior to installation, submit documentation of the experience of the telecommunications contractor and of the key personnel.

1.6.2.1 Telecommunications Contractor

The telecommunications contractor shall be a firm which is regularly and professionally engaged in the business of the applications, installation, and testing of the specified telecommunications systems and equipment. The telecommunications contractor shall demonstrate experience in providing successful telecommunications systems within the past 3 years of similar scope and size. Submit documentation for a minimum of three and a maximum of five successful telecommunication system installations for the telecommunications contractor.

1.6.2.2 Key Personnel

Provide key personnel who are regularly and professionally engaged in the business of the application, installation and testing of the specified telecommunications systems and equipment. There may be one key person or more key persons proposed for this solicitation depending upon how many of the key roles each has successfully provided. Each of the key personnel shall demonstrate experience in providing successful telecommunications systems within the past 3 years.

Supervisors and installers assigned to the installation of this system or any of its components shall be Building Industry Consulting Services International (BICSI) Registered Cabling Installers, Technician Level. Submit documentation of current BICSI certification for each of the key personnel.

In lieu of BICSI certification, supervisors and installers assigned to the installation of this system or any of its components shall have a minimum of 3 years experience in the installation of the specified copper and fiber optic cable and components. They shall have factory or factory approved certification from each equipment manufacturer indicating that they are qualified to install and test the provided products. Submit documentation for a minimum of three and a maximum of five successful telecommunication system installations for each of the key personnel. Documentation for each key person shall include at least two successful system installations provided that are equivalent in system size and in construction complexity to the telecommunications system proposed for this solicitation. Include specific experience in installing and testing telecommunications systems and provide the names and locations of at least two project installations successfully completed using optical fiber and copper telecommunications cabling systems. All of the existing telecommunications system installations offered by the key persons as successful experience shall have been in successful full-time service for at least 18 months prior to the issuance date for this solicitation.

Provide the name and role of the key person, the title, location, and completed installation date of the referenced project, the referenced project owner point of contact information including name, organization, title, and telephone number, and generally, the referenced project description including system size and construction complexity.

Indicate that all key persons are currently employed by the telecommunications contractor, or have a commitment to the telecommunications contractor to work on this project. All key persons shall be employed by the telecommunications contractor at the date of issuance of this solicitation, or if not, have a commitment to the telecommunications contractor to work on this project by the date that the bid was due to the Contracting Officer.

Note that only the key personnel approved by the Contracting Officer in the successful proposal shall do work on this solicitation's telecommunications system. Key personnel shall function in the same roles in this contract, as they functioned in the offered successful experience. Any substitutions for the telecommunications contractor's key personnel requires approval from The Contracting Officer.

1.6.2.3 Minimum [Manufacturer Qualifications](#)

Cabling, equipment and hardware manufacturers shall have a minimum of 3 years experience in the manufacturing, assembly, and factory testing of components which comply with [TIA-568.1](#), [TIA-568.2](#) and [TIA-568.3](#).

1.6.3 [Test Plan](#)

Provide a complete and detailed test plan for the telecommunications cabling system including a complete list of test equipment for the components and accessories for each cable type specified, 60 days prior to the proposed test date. Include procedures for certification, validation, and testing.

1.6.4 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Equipment, materials, installation, and workmanship shall be in accordance with the mandatory and advisory provisions of [NFPA 70](#) unless more stringent requirements are specified or indicated.

1.6.5 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Where two or more items of the same class of equipment are required, these items shall be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless

stated in this section.

1.6.5.1 Alternative Qualifications

Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

1.6.5.2 Material and Equipment Manufacturing Date

Products manufactured more than 1 year prior to date of delivery to site shall not be used, unless specified otherwise.

1.7 DELIVERY AND STORAGE

Provide protection from weather, moisture, extreme heat and cold, dirt, dust, and other contaminants for telecommunications cabling and equipment placed in storage.

1.8 ENVIRONMENTAL REQUIREMENTS

Connecting hardware shall be rated for operation under ambient conditions of 32 to 140 degrees F and in the range of 0 to 95 percent relative humidity, noncondensing.

1.9 WARRANTY

The equipment items shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

1.10 MAINTENANCE

1.10.1 Operation and Maintenance Manuals

Commercial off the shelf manuals shall be furnished for operation, installation, configuration, and maintenance of products provided as a part of the telecommunications cabling and pathway system, Data Package 5. Submit operations and maintenance data in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA and as specified herein not later than 2 months prior to the date of beneficial occupancy. In addition to requirements of Data Package 5, include the requirements of paragraphs TELECOMMUNICATIONS DRAWINGS, TELECOMMUNICATIONS SPACE DRAWINGS, and RECORD DOCUMENTATION. Ensure that these drawings and documents depict the as-built configuration.

1.10.2 Record Documentation

Provide T5 drawings including documentation on cables and termination hardware in accordance with TIA-606. T5 drawings shall include schedules to show information for cut-overs and cable plant management, patch panel layouts and cover plate assignments, cross-connect information and connecting terminal layout as a minimum. T5 drawings shall be provided in hard copy format and on electronic media using Windows based computer cable management software. A licensed copy of the cable management software including documentation, shall be provided. Provide the following T5 drawing documentation as a minimum:

- a. Cables - A record of installed cable shall be provided in accordance with TIA-606. The cable records shall include the required data fields for each cable and complete end-to-end circuit report for each complete circuit from the assigned outlet to the entry facility in accordance with TIA-606. Include manufacture date of cable with submittal.
- b. Termination Hardware - A record of installed patch panels, cross-connect points, distribution frames, terminating block arrangements and type, and outlets shall be provided in accordance with TIA-606. Documentation shall include the required data fields in accordance with TIA-606.

PART 2 PRODUCTS

2.1 COMPONENTS

Components shall be UL or third party certified. Where equipment or materials are specified to conform to industry and technical society reference standards of the organizations, submit proof of such compliance. The label or listing by the specified organization will be acceptable evidence of compliance. In lieu of the label or listing, submit a certificate from an independent testing organization, competent to perform testing, and approved by the Contracting Officer. The certificate shall state that the item has been tested in accordance with the specified organization's test methods and that the item complies with the specified organization's reference standard. Provide a complete system of telecommunications cabling and pathway components using star topology. Provide support structures and pathways, complete with outlets, cables, connecting hardware and telecommunications cabinets/racks. Cabling and interconnecting hardware and components for telecommunications systems shall be UL listed or third party independent testing laboratory certified, and shall comply with NFPA 70 and conform to the requirements specified herein.

2.2 TELECOMMUNICATIONS PATHWAY

Provide telecommunications pathways in accordance with TIA-569 and as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Provide system furniture pathways in accordance with UL 1286.

2.3 TELECOMMUNICATIONS CABLING

Cabling shall be UL listed for the application and shall comply with TIA-568.0, TIA-568.1, TIA-568.2, TIA-568.3 and NFPA 70. Provide a labeling system for cabling as required by TIA-606 and UL 969. Ship cable on reels or in boxes bearing manufacture date for for unshielded twisted pair (UTP) in accordance with ICEA S-90-661 and optical fiber cables in accordance with ICEA S-83-596 for all cable used on this project. Cabling manufactured more than 12 months prior to date of installation shall not be used.

2.3.1 Backbone Cabling

2.3.2 Horizontal Cabling

Provide horizontal cable in compliance with NFPA 70 and performance characteristics in accordance with TIA-568.1.

2.3.2.1 Horizontal Copper

Provide horizontal copper cable, UTP, 100 ohm in accordance with TIA-568.2, UL 444, ANSI/NEMA WC 66, ICEA S-90-661. Provide four each individually twisted pair, minimum size 24 AWG conductors, Category 6, with a green for data, blue for wireless access points and yellow for POS cabling with thermoplastic jacket. Cable shall be imprinted with manufacturers name or identifier, flammability rating, gauge of conductor, transmission performance rating (category designation) and length marking at regular intervals in accordance with ICEA S-90-661. Provide plenum (CMP), riser (CMR), or general purpose (CM or CMG) communications rated cabling in accordance with NFPA 70. Substitution of a higher rated cable shall be permitted in accordance with NFPA 70. Cables installed in conduit within and under slabs shall be UL listed and labeled for wet locations in accordance with NFPA 70.

2.4 TELECOMMUNICATIONS SPACES

Provide connecting hardware and termination equipment in the telecommunications entrance facility and telecommunication equipment room to facilitate installation as shown on design drawings for terminating and cross-connecting permanent cabling. Provide telecommunications interconnecting hardware color coding in accordance with TIA-606.

2.4.1 Backboards

Provide void-free, interior grade A-C plywood 3/4 inch thick 4 by 8 feet and covering all walls.. Backboards shall be fire rated by manufacturing process. Fire stamp shall be clearly visible. Paint applied over fire retardant backboard shall be UL 723 fire retardant gray paint. Provide label including paint manufacturer, date painted, UL listing and name of Installer. When painted, paint label and fire stamp shall be clearly visible. Backboards shall be provided on a minimum of two adjacent walls in the telecommunication spaces.

2.4.2 Equipment Support Frame

Provide in accordance with ECIA EIA/ECA 310-E and UL 50.

Bracket, wall mounted, 8 gauge aluminum. Provide hinged bracket c. Relocate existing telecommunications cabinet as indicated. Re-use equipment as indicated.

2.4.3 Cable Guides

Provide cable guides specifically manufactured for the purpose of routing cables, wires and patch cords horizontally and vertically on cabinet and telecommunications backboards. Cable guides of ring or bracket type devices mounted on cabinet and backboard for horizontal cable management and individually mounted for vertical cable management. Mount cable guides with screws, or nuts and lockwashers.

2.4.4 Patch Panels

Re-use existing patch panels as indicated on drawings.. Patch cords shall meet minimum performance requirements specified in TIA-568.1, TIA-568.2 or as indicated on drawings for cables, cable length and hardware specified.

2.4.4.1 Fiber Optic Patch Panel

Re-use existing fiber optic patch panels as indicated on drawings. Provide fusion splices as indicated.

2.5 TELECOMMUNICATIONS OUTLET/CONNECTOR ASSEMBLIES

2.5.1 Outlet/Connector Copper

Outlet/connectors shall comply with FCC Part 68, TIA-568.1, and TIA-568.2. UTP outlet/connectors shall be UL 1863 listed, non-keyed, 8-pin modular, constructed of high impact rated thermoplastic housing and shall be third party verified and shall comply with TIA-568.2 Category 6 requirements. Outlet/connectors provided for UTP cabling shall meet or exceed the requirements for the cable provided. Outlet/connectors shall be terminated using a Type 110 IDC PC board connector, color-coded for both T568A and T568B wiring. Each outlet/connector shall be wired as indicated. UTP outlet/connectors shall comply with TIA-568.2 for 200 mating cycles. UTP outlet/connectors installed in outdoor environments shall be jell-filled type containing an anti-corrosive, memory retaining compound.

2.5.2 Optical Fiber Adapters(Couplers)

Provide optical fiber adapters suitable for duplex LC in accordance with TIA/EIA-604-10 with zirconia ceramic alignment sleeves, as indicated. Provide dust cover for adapters. Optical fiber adapters shall comply with TIA-455-21 for 500 mating cycles.

2.5.3 Optical Fiber Connectors

Provide in accordance with TIA-455-21. Optical fiber connectors shall be duplex LC in accordance with TIA/EIA-604-10 with zirconia ceramic alignment sleeves, compatible with existing fiber optic cable already installed in the facility..

2.5.4 Cover Plates

Telecommunications cover plates shall comply with UL 514C, and TIA-568.1, ; flush design constructed of 302 stainless material. Provide labeling in accordance with the paragraph LABELING in this section.

2.6 GROUNDING AND BONDING PRODUCTS

Provide in accordance with UL 467, TIA-607, and NFPA 70. Components shall be identified as required by TIA-606. Provide bonding conductors, and grounding busbars as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

2.7 FIRESTOPPING MATERIAL

Provide as specified in Section 07 84 00 FIRESTOPPING.

2.8 MANUFACTURER'S NAMEPLATE

Each item of equipment shall have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

2.9 FIELD FABRICATED NAMEPLATES

ASTM D709. Provide laminated plastic nameplates for each equipment enclosure, relay, switch, and device; as specified or as indicated on the drawings. Each nameplate inscription shall identify the function and, when applicable, the position. Nameplates shall be melamine plastic, **0.125 inches** thick, white with black center core. Surface shall be matte finish. Corners shall be square. Accurately align lettering and engrave into the core. Minimum size of nameplates shall be **one by 2.5 inches**. Lettering shall be a minimum of **0.25 inches** high normal block style.

2.10 TESTS, INSPECTIONS, AND VERIFICATIONS

2.10.1 Factory Reel Tests

Provide documentation of the testing and verification actions taken by manufacturer to confirm compliance with **TIA-568.1**, **TIA-568.2**, **TIA-568.3**, **TIA-526-7** for single mode optical fiber , and **TIA-526-14** for multimode optical fiber cables.

PART 3 EXECUTION

3.1 INSTALLATION

Install telecommunications cabling and pathway systems, including the horizontal and backbone cable, pathway systems, telecommunications outlet/connector assemblies, and associated hardware in accordance with **NECA/BICSI 568**, **TIA-568.1**, **TIA-568.2**, **TIA-569**, **NFPA 70**, and UL standards as applicable. Provide cabling in a star topology network. Pathways and outlet boxes shall be installed as specified in Section **26 20 00** INTERIOR DISTRIBUTION SYSTEM. Install telecommunications cabling with copper media in accordance with the following criteria to avoid potential electromagnetic interference between power and telecommunications equipment. The interference ceiling shall not exceed 3.0 volts per meter measured over the usable bandwidth of the telecommunications cabling. Cabling shall be run with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.

3.1.1 Cabling

Install UTP, and optical fiber telecommunications cabling system as detailed in **TIA-568.1**. . Screw terminals shall not be used except where specifically indicated on plans. Use an approved insulation displacement connection (IDC) tool kit for copper cable terminations. Do not exceed manufacturers' cable pull tensions for copper and optical fiber cables. Provide a device to monitor cable pull tensions. Do not exceed **25 pounds** pull tension for four pair copper cables. Do not chafe or damage outer jacket materials. Use only lubricants approved by cable manufacturer. Do not over cinch cables, or crush cables with staples. For UTP cable, bend radii shall not be less than four times the cable diameter. Cables shall be terminated; no cable shall contain unterminated elements. Cables shall not be spliced. Label cabling in accordance with paragraph LABELING in this section.

3.1.1.1 Backbone Cable

- a. Optical fiber Backbone Cable. Install intrabuilding backbone optical fiber in indicated pathways. Do not exceed manufacturer's recommended

bending radii and pull tension. Prepare cable for pulling by cutting outer jacket **10 inches** leaving strength members exposed for approximately **10 inches**. Twist strength members together and attach to pulling eye. Vertical cable support intervals shall be in accordance with manufacturer's recommendations.

3.1.1.2 Horizontal Cabling

Install horizontal cabling as indicated on drawings. Do not untwist Category 6 UTP cables more than **one half inch** from the point of termination to maintain cable geometry. Provide slack cable in the form of a figure eight (not a service loop) on each end of the cable, **10 feet** in the telecommunications room, and **12 inches** in the work area outlet.

3.1.2 Pathway Installations

Provide in accordance with **TIA-569** and **NFPA 70**. Provide building pathway as specified in Section **26 20 00** INTERIOR DISTRIBUTION SYSTEM.

3.1.3 Service Entrance Conduit, Underground

Provide service entrance underground as specified in Section **26 20 00** INTERIOR DISTRIBUTION SYSTEM.

3.1.4 Work Area Outlets

3.1.4.1 Terminations

Terminate UTP cable in accordance with **TIA-568.1**, **TIA-568.2** and wiring configuration as specified. Terminate fiber optic cables in accordance with **TIA-568.3**.

3.1.4.2 Cover Plates

As a minimum, each outlet/connector shall be labeled as to its function and a unique number to identify cable link in accordance with the paragraph LABELING in this section.

3.1.4.3 Cables

Unshielded twisted pair and fiber optic cables shall have a minimum of **12 inches** of slack cable loosely coiled into the telecommunications outlet boxes. Minimum manufacturer's bend radius for each type of cable shall not be exceeded.

3.1.4.4 Pull Cords

Pull cords shall be installed in conduit serving telecommunications outlets that do not have cable installed.

3.1.5 Telecommunications Space Termination

Install termination hardware required for Category 6 and optical fiber system. An insulation displacement tool shall be used for terminating copper cable to insulation displacement connectors.

3.1.5.1 Patch Panels

Ensure patch panels **are** mounted in equipment cabinets with sufficient

ports to accommodate the installed cable plant.

- a. Copper Patch Panel. Copper cable entering a patch panel shall be secured to the panel with cable ties to prevent movement of the cable.
- b. Fiber Optic Patch Panel. Fiber optic cable loop shall be 3 feet in length. The outer jacket of each cable entering a patch panel shall be secured to the panel to prevent movement of the fibers within the panel, using clamps or brackets specifically manufactured for that purpose.

3.1.5.2 Equipment Support Frames

Install in accordance with TIA-569:

- a. Bracket, wall mounted. Mount bracket to plywood backboard in accordance with manufacturer's recommendations. Mount rack so height of highest panel does not exceed 78 inches above floor.
- b. Cabinets, wall-mounted modular type. Mount cabinet to plywood backboard in accordance with manufacturer's recommendations. Mount cabinet so height of highest panel does not exceed 78 inches above floor.

3.1.6 Electrical Penetrations

Seal openings around electrical penetrations through fire resistance-rated wall, partitions, floors, or ceilings as specified in Section 07 84 00 FIRESTOPPING.

3.1.7 Grounding and Bonding

Provide in accordance with TIA-607, NFPA 70 and as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

3.2 LABELING

3.2.1 Labels

Provide labeling in accordance with TIA-606. Handwritten labeling is unacceptable. Stenciled lettering for voice and data circuits shall be provided using laser printer.

3.2.2 Cable

Cables shall be labeled using color labels on both ends with identifiers in accordance with TIA-606.

3.2.3 Termination Hardware

Workstation outlets and patch panel connections shall be labeled using color coded labels with identifiers in accordance with TIA-606.

3.3 FIELD APPLIED PAINTING

Paint electrical equipment as required to match finish of adjacent surfaces or to meet the indicated or specified safety criteria. Painting shall be as specified in Section 09 90 00 PAINTS AND COATINGS.

3.3.1 Painting Backboards

If backboards are required to be painted, then the manufactured fire retardant backboard must be painted with fire retardant paint, so as not to increase flame spread and smoke density and must be appropriately labeled. Label and fire rating stamp must be unpainted.

3.4 FIELD FABRICATED NAMEPLATE MOUNTING

Provide number, location, and letter designation of nameplates as indicated. Fasten nameplates to the device with a minimum of two sheet-metal screws or two rivets.

3.5 TESTING

3.5.1 Telecommunications Cabling Testing

Perform telecommunications cabling inspection, verification, and performance tests in accordance with TIA-568.1, . Test equipment shall conform to TIA-1152. Perform optical fiber field inspection tests via attenuation measurements on factory reels and provide results along with manufacturer certification for factory reel tests. Remove failed cable reels from project site upon attenuation test failure.

3.5.1.1 Inspection

Visually inspect UTP and optical fiber jacket materials for UL or third party certification markings. Inspect cabling terminations in telecommunications rooms and at workstations to confirm color code for T568A or T568B pin assignments, and inspect cabling connections to confirm compliance with TIA-568.1, TIA-568.2, . Visually confirm Category 6, marking of outlets, cover plates, outlet/connectors, and patch panels.

3.5.1.2 Verification Tests

UTP backbone copper cabling shall be tested for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors, and between conductors and shield, if cable has overall shield. Test operation of shorting bars in connection blocks. Test cables after termination but prior to being cross-connected.

For multimode optical fiber, perform optical fiber end-to-end attenuation tests in accordance with TIA-568.3 and TIA-526-14 using Method A, Optical Power Meter and Light Source. For single-mode optical fiber, perform optical fiber end-to-end attenuation tests in accordance with TIA-568.3 and TIA-526-7 using Method A, Optical Power Meter and Light Source for single-mode optical fiber. Perform verification acceptance tests.

3.5.1.3 Performance Tests

Perform testing for each outlet and MUTOA as follows:

- a. Perform Category 6 link tests in accordance with TIA-568.1 and TIA-568.2. Tests shall include wire map, length, insertion loss, NEXT, PSNEXT, ELFEXT, PSELFEXT, return loss, propagation delay, and delay skew.

-- End of Section --

SECTION 28 31 76

INTERIOR FIRE ALARM AND MASS NOTIFICATION SYSTEM, ADDRESSABLE
08/20

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ACOUSTICAL SOCIETY OF AMERICA (ASA)

ASA S3.2 (2020) American National Standard Method
for Measuring the Intelligibility of
Speech Over Communication Systems (ASA 85)

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME A17.1/CSA B44 (2019) Safety Code for Elevators and
Escalators

FM GLOBAL (FM)

FM APP GUIDE (updated on-line) Approval Guide
<http://www.approvalguide.com/>

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C62.41.1 (2002; R 2008) Guide on the Surges
Environment in Low-Voltage (1000 V and
Less) AC Power Circuits

IEEE C62.41.2 (2002) Recommended Practice on
Characterization of Surges in Low-Voltage
(1000 V and Less) AC Power Circuits

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 4 (2018) Standard for Integrated Fire
Protection and Life Safety System Testing

NFPA 70 (2020; ERTA 20-1 2020; ERTA 20-2 2020;
ERTA 20-3 2020; TIA 20-1; TIA 20-2; TIA
20-3; TIA 20-4; TIA 20-5; TIA 20-6; TIA
20-7; TIA 20-8; TIA 20-9; TIA 20-10; TIA
20-11; TIA 20-12; TIA 20-13; TIA 20-14;
TIA 20-15; TIA 20-16; ERTA 20-4 2022)
National Electrical Code

NFPA 72 (2022) National Fire Alarm and Signaling
Code

NFPA 90A (2021) Standard for the Installation of
Air Conditioning and Ventilating Systems

NFPA 170 (2021) Standard for Fire Safety and
Emergency Symbols

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-601-02 (2021) Fire Protection Systems Inspection,
Testing, and Maintenance

UFC 4-010-06 (2016; with Change 1, 2017) Cybersecurity
of Facility-Related Control Systems

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

47 CFR 15 Radio Frequency Devices

47 CFR 90 Private Land Mobile Radio Services

UNDERWRITERS LABORATORIES (UL)

UL 228 (2006; Reprint Mar 2022) UL Standard for
Safety Door Closers-Holders, With or
Without Integral Smoke Detectors

UL 268 (2016; Reprint Nov 2021) UL Standard for
Safety Smoke Detectors for Fire Alarm
Systems

UL 268A (2008; Reprint Oct 2014) Smoke Detectors
for Duct Application

UL 464 (2016; Reprint Sep 2017) UL Standard for
Safety Audible Signaling Devices for Fire
Alarm and Signaling Systems, Including
Accessories

UL 497A (2001; Bul. 2019) UL Standard for Safety
Secondary Protectors for Communications
Circuits

UL 497B (2004; Reprint Feb 2022) UL Standard for
Safety Protectors for Data Communications
and Fire Alarm Circuits

UL 521 (1999; Reprint Mar 2021) UL Standard for
Safety Heat Detectors for Fire Protective
Signaling Systems

UL 864 (2014; Reprint May 2020) UL Standard for
Safety Control Units and Accessories for
Fire Alarm Systems

UL 1283 (2017) UL Standard for Safety
Electromagnetic Interference Filters

UL 1449 (2021) UL Standard for Safety Surge
Protective Devices

UL 1480 (2016; Reprint Sep 2017) UL Standard for
Safety Speakers for Fire Alarm and

Signaling Systems, Including Accessories

UL 1638	(2016; Reprint Sep 2017) UL Standard for Safety Visible Signaling Devices for Fire Alarm and Signaling Systems, Including Accessories
UL 1971	(2002; Reprint Oct 2008) Signaling Devices for the Hearing Impaired
UL 2017	(2008; Reprint Dec 2018) UL Standard for Safety General-Purpose Signaling Devices and Systems
UL 2034	(2017; Reprint Apr 2022) UL Standard for Safety Single and Multiple Station Carbon Monoxide Alarms
UL 2075	(2013; Bul. 2019) UL Standard for Safety Gas and Vapor Detectors and Sensors
UL 2572	(2016; Bul. 2018) UL Standard for Safety Mass Notification Systems
UL Fire Prot Dir	(2012) Fire Protection Equipment Directory

1.2 RELATED SECTIONS

Section 07 84 00 FIRESTOPPING for additional work related to firestopping.

1.3 SUMMARY

1.3.1 Scope

- a. This work includes designing and providing a new, complete, fire alarm and mass notification (MNS) system as described herein and on the contract drawings for the buildings indicated on the contract drawings. Include system wiring, raceways, pull boxes, terminal cabinets, outlet and mounting boxes, control equipment, initiating devices, notification appliances, supervising station fire alarm transmitters/mass notification transceiver, and other accessories and miscellaneous items required for a complete operational system even though each item is not specifically mentioned or described. Provide systems complete and ready for operation. Design and installation must comply with UFC 4-010-06 and AFGM 2019-320-02.
- b. Provide equipment, materials, installation, workmanship, inspection, and testing in strict accordance with NFPA 72, except as modified herein. The system layout on the drawings show the intent of coverage and suggested locations. Final quantity, system layout, and coordination are the responsibility of the Contractor.
- c. Each remote fire alarm control unit must be powered from a wiring riser specifically for that use or from a local emergency power panel (if available) located on the same floor as the remote fire alarm control unit. Where remote fire control units are provided, equipment for notification appliances may be located in the remote fire alarm control units.

- d. Where a fire pump is provided, the fire alarm and mass notification system must monitor and transmit the fire pump controller signals in accordance with the provisions of NFPA 72.f. The fire alarm and mass notification system must be independent of the building security, building management, and energy/utility monitoring systems other than for control functions.

1.4 DEFINITIONS

Wherever mentioned in this specification or on the drawings, the equipment, devices, and functions must be defined as follows:

1.4.1 Interface Device

An addressable device that interconnects hard wired systems or devices to an analog/addressable system.

1.4.2 Fire Alarm and Mass Notification Control Unit (FMCU)

A master control unit having the features of a fire alarm control unit (FACU) and an autonomous control unit (ACU) where these units are interconnected to function as a combined fire alarm/mass notification system. The FACU and ACU functions may be contained in a single cabinet or in independent, interconnected, and co-located cabinets.

1.4.3 Remote Fire Alarm and Mass Notification Control Unit

A control unit, physically remote from the fire alarm and mass notification control unit, that receives inputs from automatic and manual fire alarm devices; may supply power to detection devices and interface devices; may provide transfer of power to the notification appliances; may provide transfer of condition to relays or devices connected to the control unit; and reports to and receives signals from the fire alarm and mass notification control unit.

1.4.4 Local Operating Console (LOC)

A unit designed to allow emergency responders and/or building occupants to operate the MNS including delivery of recorded messages and/or live voice announcements, initiate visual, textual visual, and audible appliance operation and other relayed functions.

1.4.5 Terminal Cabinet

A steel cabinet with locking, hinge-mounted door where terminal strips are securely mounted inside the cabinet.

1.4.6 Control Module and Relay Module

Terms utilized to describe emergency control function interface devices as defined by NFPA 72.

1.4.7 Designated Fire Protection Engineer (DFPE)

The DoD fire protection engineer that oversees that Area of Responsibility for that project. This is sometimes referred to as the "cognizant" fire protection engineer. Interpret reference to "authority having jurisdiction" and/or AHJ in referenced standards to mean the Designated

Fire Protection Engineer (DFPE). The DFPE may be responsible for review of the contractor submittals having a "G" designation, and for witnessing final inspection and testing.

1.5 SUBMITTALS

Government approval is required for submittals.

Shop drawings (SD-02), product data (SD-03) and calculations (SD-05) must be prepared by the fire alarm designer and combined and submitted as one complete package. The QFPE must review the SD-02/SD-03/SD-05 submittal package for completeness and compliance with the Contract provisions prior to submission to the Government. The QFPE must provide a Letter of Confirmation that they have reviewed the submittal package for compliance with the contract provisions. This letter must include their registered professional engineer stamp and signature. Partial submittals and submittals not reviewed by the QFPE will be returned by the Government disapproved without review.

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Fire alarm system designer

Supervisor

Technician

Installer

Test Technician

Fire Alarm System Site-Specific Software Acknowledgement

SD-02 Shop Drawings

Nameplates

Instructions

Wiring Diagrams

System Layout

Notification Appliances

Initiating Devices

Amplifiers

Battery Power

Voltage Drop Calculations

Textual Display Sign Control Panel

SD-03 Product Data

Fire Alarm and Mass Notification Control Unit (FMCU)

Local Operating Console (LOC)

Amplifiers

Tone Generators

Digitalized voice generators

Manual Stations

Smoke Detectors

Duct Smoke Detectors

Heat Detectors

Carbon monoxide detector

Addressable Interface Devices

Addressable Control Modules

Notification Appliances

Textual Display Signs

Batteries

Battery Chargers

Supplemental Notification Appliance Circuit Panels

Auxiliary Power Supply Panels

Surge Protective Devices

Alarm Wiring

Back Boxes and Conduit

Ceiling Bridges for Ceiling-Mounted Appliances

Terminal Cabinets

Automatic Fire Alarm Transmitters (including housing)

Radio Transmitter and Interface Panels

Mass Notification Transceiver

Electromagnetic Door Holders

Environmental Enclosures or Guards

Document Storage Cabinet

SD-05 Design Data

SD-06 Test Reports

Test Procedures

SD-07 Certificates

Verification of Compliant Installation

Request for Government Final Test

SD-10 Operation and Maintenance Data

Operation and Maintenance (O&M) Instructions

Instruction of Government Employees

SD-11 Closeout Submittals

As-Built Drawings

Spare Parts

1.6 SYSTEM OPERATION

Fire alarm system/mass notification system including control panel(s), components requiring power, except for the FMCU(s) power supply, must operate on 24 volts DC unless noted otherwise in this section.

The interior fire alarm and mass notification system must be a complete, supervised, noncoded, analog/addressable fire alarm and mass notification system conforming to NFPA 72, UL 864, and UL 2572. Systems meeting UL 2017 only are not acceptable. The system must be activated into the alarm mode by actuation of an alarm initiating device. The system must remain in the alarm mode until the initiating device is reset and the control unit is reset and restored to normal. The system may be placed in the alarm mode by local microphones, LOC, FMCU, or remotely from authorized locations/users.

All fire alarm and mass notification systems shall be installed per UFC 4-021-01, UFC 3-600-01, NFPA 70, International Building Code and NFPA 101 (current editions).

1.6.1 Alarm Initiating Devices and Notification Appliances (Visual, Voice, Textual)

- a. Connect alarm initiating devices to initiating device circuits (IDC) Class "A", or to signaling line circuits (SLC) Class "A" and installed in accordance with NFPA 72.
- b. Connect notification appliances to notification appliance circuits (NAC) Class "A".

1.6.2 Functions and Operating Features

The system must provide the following functions and operating features:

- a. Power, annunciation, supervision, and control for the system. Addressable systems must be microcomputer (microprocessor or

microcontroller) based with a minimum word size of eight bits with sufficient memory to perform as specified.

- b. Visual alarm notification appliances must be synchronized as required by NFPA 72.
- c. Electrical supervision of the primary power (AC) supply, presence of the battery, battery voltage, and placement of system modules within the control unit.
- d. An audible and visual trouble signal to activate upon a single break or open condition, or ground fault. The trouble signal must also operate upon loss of primary power (AC) supply, absence of a battery supply, low battery voltage, or removal of alarm or supervisory control unit modules. After the system returns to normal operating conditions, the trouble signal must again sound until the trouble is acknowledged. A smoke detector in the process of being verified for the actual presence of smoke must not initiate a trouble condition.
- e. A trouble signal silence feature that must silence the audible trouble signal, without affecting the visual indicator.
- f. Program capability via switches in a locked portion of the FMCU to bypass the automatic notification appliance circuits, air handler shutdown, smoke control operation, elevator recall, door release and door unlocking features. Operation of this programmed action must indicate on the FMCU display as a supervisory or trouble condition. Notification appliance bypass must be selectable by floor.
- g. Alarm functions must override trouble or supervisory functions. Supervisory functions must override trouble functions.
- h. The system must be capable of being programmed from the control unit keyboard. Programmed information must be stored in non-volatile memory.
- i. The system must be capable of operating, supervising, and/or monitoring non-addressable alarm and supervisory devices.
- j. There must be no limit, other than maximum system capacity, as to the number of addressable devices that may be in alarm simultaneously.
- k. Where the fire alarm/mass notification system is responsible for initiating an action in another emergency control device or system, such as HVAC, atrium exhaust, smoke control, elevator recall, releasing service, the addressable fire alarm relay must be located in the vicinity of the emergency control device.
- l. An alarm signal must automatically initiate the following functions:
 - (1) Transmission of point-to-point alarm signals by radio to the Emergency Command Center (ECC) via the Monaco D-21 Central Receiving Station located in Building 929 (Maxwell AFB Fire Department Dispatch). Signals transmitted shall be in real time. The FA/MNS shall be compatible with and shall communicate seamlessly with the D-21 Central Receiving Station without impairing operational function or reliability of any existing FACP or MNS. use of interfacing relays between the FACP and communications transceiver to provide point or zonal alarm or

- trouble conditions will not be permitted.
- (2) Visual indication of the device operated on the FMCU, remote annunciators LOC's and LOC/RDU's..
 - (3) Actuation of alarm notification appliances.
 - (4) Recording of the event electronically in the history log of the FMCU.
 - (5) Release of doors held open by electromagnetic devices.
 - (6) Operation of the smoke control system or atrium exhaust systems (if applicable).
 - (7) Release of power to electric locks (delayed egress locks) on doors that are part of the means of egress.
 - (8) Elevator recall as described in this section.
 - (9) Operation of computer area manual pull station and/or the alarms of two room/area smoke detectors must release the gas-type fire extinguishing system after a 45 second time delay. During the 45 second delay the audio visual device in that area only will sound an alarm.
 - (10) Operation of a sprinkler waterflow switch serving an elevator machinery room or elevator shaft must operate shunt trip circuit breaker(s) to shut down power to the elevators in accordance with ASME A17.1/CSA B44.
- m. A supervisory signal must automatically initiate the following functions:
- (1) Visual indication of the device operated on the FMCU, the remote annunciator, LOC or LOC/RDU.
 - (2) Transmission of point-to-point alarm signals by radio to the Emergency Command Center (ECC) via the Monaco D-21 Central Receiving Station located in Building 929 (Maxwell AFB Fire Department Dispatch). Signals transmitted shall be in real time. The FA/MNS shall be compatible with and shall communicate seamlessly with the D-21 Central Receiving Station without impairing operational function or reliability of any existing FACP or MNS. use of interfacing relays between the FACP and communications transceiver to provide point or zonal alarm or trouble conditions will not be permitted..
 - (3) Operation of a duct smoke detector must shut down the appropriate air handler in accordance with NFPA 90A in addition to other requirements of this paragraph and as allowed by NFPA 72.
 - (4) Recording of the event electronically in the history log of the FMCU.
- n. A trouble condition must automatically initiate the following functions:
- (1) Visual indication of the device operated on the FMCU, the remote annunciator and LOC or LOC/RDU.

- (2) Transmission of a trouble signal to the Emergency Command Center (ECC) via the Monaco D-21 Central Receiving Station station located in Building 929 (Maxwell AFB Fire Department Dispatch). Signals transmitted shall be in real time. The FA/MNS shall be compatible with and shall communicate seamlessly with the D-21 Central Receiving Station without impairing operational function or reliability of any existing FACP or MNS. use of interfacing relays between the FACP and communications transceiver to provide point or zonal alarm or trouble conditions will not be permitted. .
 - (3) Recording of the event electronically in the history log of the FMCU.
- o. Activation of a carbon monoxide alarm initiating device must automatically initiate the following functions:
- (1) Visual indication of the device operated on the FMCU, theremote annunciator and the LOC or the LOC/RDU.
 - (2) Transmission of a carbon monoxide alarm signal to the Emergency Command Center (ECC) via the Monaco D-21 Central Receiving Station station located in Building 929 (Maxwell AFB Fire Department Dispatch). Signals transmitted shall be in real time. The FA/MNS shall be compatible with and shall communicate seamlessly with the D-21 Central Receiving Station without impairing operational function or reliability of any existing FACP or MNS. use of interfacing relays between the FACP and communications transceiver to provide point or zonal alarm or trouble conditions will not be permitted.
 - (3) Activation of all strobes and the audible carbon monoxide message throughout the building.
 - (4) Recording of the event electronically in the history log of the FMCU.
- p. Activation of a LOC pushbutton must activate the audible and visual alarms in the facility. The audible message must be the one associated with the pushbutton activated.

1.6.3 Elevator Recall

Connect to existing elevator recall at each elevator controller location. Activation of any smoke detector in an elevator shaft, machine room, or lobby (except at designated recall level) must cause all elevators associated with that shaft, machine room, or lobby to return nonstop to the designated level. Activation of a smoke detector in the lobby or machine room at the designated level must cause all elevators associated with that lobby to return nonstop to the assigned alternate level. Activation of a detector in an elevator shaft, machine room, or lobby must also cause illumination of elevator cab warning signal (fire hat) and complete operation of fire alarm system as specified in paragraph titled "Functions and Operating Features".

1.7 TECHNICAL DATA AND SITE-SPECIFIC SOFTWARE

Technical data and site-specific software (meaning technical data that relates to computer software) that are specifically identified in this

project, and may be required in other specifications, must be delivered, strictly in accordance with the CONTRACT CLAUSES. The fire alarm system manufacturer must submit written confirmation of this contract provision as "[Fire Alarm System Site-Specific Software Acknowledgement](#)". Identify data delivered by reference to the specification paragraph against which it is furnished. Data to be submitted must include complete system, equipment, and software descriptions. Descriptions must show how the equipment will operate as a system to meet the performance requirements of this contract. The site-specific software data package must also include the following:

- a. Items identified in [NFPA 72](#), titled "Site-Specific Software".
- b. Identification of programmable portions of the system equipment and capabilities.
- c. Description of system revision and expansion capabilities and methods of implementation detailing both equipment and software requirements.
- d. Provision of operational software data on all modes of programmable portions for fire alarm and mass notification.
- e. Description of Fire Alarm and Mass Notification Control Unit equipment operation.
- f. Description of auxiliary and remote equipment operations.
- g. Library of application software.
- h. Operation and maintenance manuals.

1.8 QUALITY ASSURANCE

1.8.1 Submittal Documents

1.8.1.1 Preconstruction Submittals

Within 36 days of contract award but not less than 14 days prior to commencing any work on site, the Contractor must submit the following for review and approval. SD-02, SD-03 and SD-05 submittals received prior to the review and approval of the qualifications of the fire alarm subcontractor and QFPE must be returned disapproved without review. All resultant delays must be the sole responsibility of the Contractor.

1.8.1.2 Shop Drawings

Shop drawings must not be smaller than the Contract Drawings. Drawings must comply with the requirements of [NFPA 72](#) and [NFPA 170](#). Minimum scale for floor plans must be 1/8"=1'.

1.8.1.3 [Nameplates](#)

Nameplate illustrations and data to obtain approval by the Contracting Officer before installation.

1.8.1.4 [Wiring Diagrams](#)

6 copies of point-to-point wiring diagrams showing the points of connection and terminals used for electrical field connections in the

system, including interconnections between the equipment or systems that are supervised or controlled by the system. Diagrams must show connections from field devices to the FMCU and remote FMCU, initiating circuits, switches, relays and terminals, including pathway diagrams between the control unit and shared communications equipment within the protected premises. Point-to-point wiring diagrams must be job specific and must not indicate connections or circuits not being utilized. Provide complete riser diagrams indicating the wiring sequence of all devices and their connections to the control equipment. Include a color-code schedule for the wiring.

1.8.1.5 System Layout

6 copies of plan view drawing showing device locations, terminal cabinet locations, junction boxes, other related equipment, conduit routing, conduit sizes, wire counts, conduit fill calculations, wire color-coding, circuit identification in each conduit, and circuit layouts for all floors. Indicate candela rating of each visual notification appliance. Indicate the wattage of each speaker. Clearly identify the locations of isolation modules. Indicate the addresses of all devices, modules, relays, and similar. Show/identify all acoustically similar spaces. Indicate if the environment for the FMCU is within its environmental listing (e.g. temperature/humidity).

Provide a complete description of the system operation in matrix format similar to the "Typical Input/Output Matrix" included in the Annex of NFPA 72.

1.8.1.6 Notification Appliances

Calculations and supporting data on each circuit to indicate that there is at least 25 percent spare capacity for notification appliances. Annotate data for each circuit on the drawings.

1.8.1.7 Initiating Devices

Calculations and supporting data on each circuit to indicate that there is at least 25 percent spare capacity for initiating devices. Annotate data for each circuit on the drawings.

1.8.1.8 Amplifiers

Calculations and supporting data to indicate that amplifiers have sufficient capacity to simultaneously drive all notification speakers at tapped settings plus 25 percent spare capacity. Annotate data for each circuit on the drawings.

1.8.1.9 Battery Power

Calculations and supporting data as required in paragraph Battery Power Calculations for alarm, alert, and supervisory power requirements. Calculations including ampere-hour requirements for each system component and each control unit component, and the battery recharging period, must be included on the drawings.

1.8.1.10 Voltage Drop Calculations

Voltage drop calculations for each notification circuit indicating that sufficient voltage is available for proper operation of the system and all

components, at a minimum rated voltage of the system operating on batteries. Include the calculations on the system layout drawings.

1.8.1.11 Product Data

6 copies of annotated descriptive data to show the specific model, type, and size of each item. Catalog cuts must also indicate the NRTL listing. The data must be highlighted to show model, size, and options that are intended for consideration. Data must be adequate to demonstrate compliance with all contract requirements. Product data for all equipment must be combined into a single submittal.

Provide an equipment list identifying the type, quantity, make, and model number of each piece of equipment to be provided under this submittal. The equipment list must include the type, quantity, make and model of spare equipment. Types and quantities of equipment submitted must coincide with the types and quantities of equipment used in the battery calculations and those shown on the shop drawings.

1.8.1.12 Operation and Maintenance (O&M) Instructions

Six copies of the Operation and Maintenance Instructions. The O&M Instructions must be prepared in a single volume or in multiple volumes, with each volume indexed, and may be submitted as a Technical Data Package. Manuals must be approved prior to training. The Interior Fire Alarm And Mass Notification System Operation and Maintenance Instructions must include the following:

- a. Operating manual outlining step-by-step procedures required for system startup, operation, and shutdown. The manual must include the manufacturer's name, model number, service manual, parts list, and preliminary equipment list complete with description of equipment and their basic operating features.
- b. Maintenance manual listing routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guide. The manuals must include conduit layout, equipment layout and simplified wiring, and control diagrams of the system as installed.
- c. Complete procedures for system revision and expansion, detailing both equipment and software requirements.
- d. Software submitted for this project on CD/DVD media utilized.
- e. Printouts of configuration settings for all devices.
- f. Routine maintenance checklist. The routine maintenance checklist must be arranged in a columnar format. The first column must list all installed devices, the second column must state the maintenance activity or state no maintenance required, the third column must state the frequency of the maintenance activity, and the fourth column provided for additional comments or reference. All data (devices, testing frequencies, and similar) must comply with [UFC 3-601-02](#).
- g. A final Equipment List must be submitted with the Operating and Maintenance (O&M) manual.

1.8.1.13 As-Built Drawings

The drawings must show the system as installed, including deviations from both the project drawings and the approved shop drawings. These drawings must be submitted within two weeks after the final Government test of the system. At least one set of the as-built (marked-up) drawings must be provided at the time of, or prior to the final Government test.

1.8.2 Qualifications

1.8.2.1 Fire Alarm System Designer

The fire alarm system designer must be certified as a Level IV (minimum) Technician by National Institute for Certification in Engineering Technologies (NICET) in the Fire Alarm Systems subfield of Fire Protection Engineering Technology or meet the qualifications for a QFPE.

1.8.2.2 Supervisor

A NICET Level III or IV fire alarm technician must supervise the installation of the fire alarm/mass notification system. The fire alarm technicians supervising the installation of equipment must be factory trained in the installation, adjustment, testing, and operation of the equipment specified herein and on the drawings.

1.8.2.3 Technician

Fire alarm technicians with a minimum of four years of experience must be utilized to install and terminate fire alarm/mass notification devices, cabinets and control units. The fire alarm technicians installing the equipment must be factory trained in the installation, adjustment, testing, and operation of the equipment specified herein and on the drawings.

1.8.2.4 Installer

NICET Level II technician to assist in the installation of fire alarm/mass notification devices, cabinets and control units. A licensed electrician must be allowed to install wire, cable, conduit and backboxes for the fire alarm system/mass notification system. The fire alarm installer must be factory trained in the installation, adjustment, testing, and operation of the equipment specified herein and on the drawings.

1.8.2.5 Test Technician

Fire alarm technicians with a minimum of eight years of experience and NICET Level III or IV utilized in testing and certification of the installation of the fire alarm/mass notification devices, cabinets and control units. The fire alarm technicians testing the equipment must be factory trained in the installation, adjustment, testing, and operation of the equipment installed as part of this project.

1.8.2.6 Manufacturer

Components must be of current design and must be in regular and recurrent production at the time of installation. Provide design, materials, and devices for a protected premises fire alarm system, complete, conforming to NFPA 72, except as specified herein.

1.8.3 Regulatory Requirements

Equipment and material must be listed or approved. Listed or approved, as used in this section, means listed, labeled or approved by a Nationally Recognized Testing Laboratory (NRTL) such as [UL Fire Prot Dir](#) or [FM APP GUIDE](#). The omission of these terms under the description of any item of equipment described must not be construed as waiving this requirement. All listings or approvals by testing laboratories must be from an existing ANSI or UL published standard. The recommended practices stated in the manufacturer's literature or documentation must be considered as mandatory requirements.

1.9 DELIVERY, STORAGE, AND HANDLING

Protect equipment delivered and placed in storage from the weather, humidity, and temperature variation, dirt and dust, and other contaminants.

1.10 MAINTENANCE

1.10.1 Spare Parts

Furnish the following spare parts in the manufacturers original unopened containers:

- a. Five complete sets of system keys [for each building FA/MNS](#).
- b. Two of each type of fuse required by the system [for each building FA/MNS](#).
- c. One manual stations [for each building FA/MNS](#).
- d. Two of each type of detector installed [for each building FA/MNS](#) .
- e. Two of each type of detector base and head installed [for each building FA/MNS](#).
- f. One electromagnetic door holders [for each building FA/MNS](#).
- g. Two of each type of audible and visual alarm device installed [for each building FA/MNS](#).
- h. One textual visual notification appliance [for each building FA/MNS](#).
- i. Two of each type of addressable monitor module installed [for each building FA/MNS](#).
- j. Two of each type of addressable control module installed [for each building FA/MNS](#).
- k. Two low voltage [and one ethernet 120 VAC surge protective device for each building FA/MNS](#).

1.10.2 Special Tools

Software, connecting cables and proprietary equipment, necessary for the maintenance, testing, and reprogramming of the equipment must be furnished to the Contracting Officer, prior to the instruction of Government employees.

PART 2 PRODUCTS

2.1 GENERAL PRODUCT REQUIREMENT

All fire alarm and mass notification equipment must be listed for use under the applicable reference standards. Interfacing of [UL 864](#) or similar approved industry listing with Mass Notification equipment listed to [UL 2572](#) must be done in a laboratory listed configuration, if the software programming features cannot provide a listed interface control.

2.2 MATERIALS AND EQUIPMENT

2.2.1 Standard Products

Provide materials, equipment, and devices that have been tested by a nationally recognized testing laboratory and listed for fire protection service when so required by [NFPA 72](#) or this specification. Select material from one manufacturer, where possible, and not a combination of manufacturers, for any particular classification of materials. Material and equipment must be the standard products of a manufacturer regularly engaged in the manufacture of the products for at least 2 years prior to bid opening.

2.2.2 Nameplates

Major components of equipment must have the manufacturer's name, address, type or style, model or serial number, catalog number, date of installation, installing Contractor's name and address, and the contract number provided on a new name plate permanently affixed to the item or equipment. Major components include, but are not limited to, the following:

a. FMCU

Nameplates must be etched metal or plastic, permanently attached by screws to control units or adjacent walls.

2.2.3 Keys

Keys and locks for equipment, control units and devices must be identical. Master all keys and locks to a single key as required by the [Maxwell AFB](#) Fire Department.

2.2.4 Instructions

Provide a typeset printed or typewritten instruction card mounted behind a Lexan plastic or glass cover in a stainless steel or aluminum frame. Install the frame in a conspicuous location observable from the FMCU. The card must show those steps to be taken by an operator when a signal is received as well as the functional operation of the system under all conditions, normal, alarm, supervisory, and trouble. The instructions must also include procedures for operating live voice microphones. The instructions and their mounting location must be approved by the Contracting Officer before being posted.

2.3 FIRE ALARM AND MASS NOTIFICATION CONTROL UNIT

Provide a complete [fire alarm and mass notification control unit \(FMCU\)](#) fully enclosed in a lockable steel cabinet as specified herein.

Operations required for testing or for normal care, maintenance, and use of the system must be performed from the front of the enclosure. If more than a single unit is required at a location to form a complete control unit, the unit cabinets must match exactly. The system must be capable of defining any module as an alarm module and report alarm trouble, loss of polling, or as a supervisory module, and reporting supervisory short, supervisory open or loss of polling such as waterflow switches, valve supervisory switches, fire pump monitoring, independent smoke detection systems, relays for output function actuation.

- a. Each control unit must provide power, supervision, control, and logic for the entire system, utilizing solid state, modular components, internally mounted and arranged for easy access. Each control unit must be suitable for operation on a 120 volt, 60 hertz, normal building power supply. Provide each control unit with supervisory functions for power failure, internal component placement, and operation.
- b. Visual indication of alarm, supervisory, or trouble initiation on the FMCU must be by liquid crystal display or similar means with a minimum of 80 characters. The mass notification control unit must have the capability of temporarily deactivate the fire alarm audible notification appliances while delivering voice messages.
- c. Provide secure operator console for initiating recorded messages, strobes and displays; and for delivering live voice messages. Provide capacity for at least eight prerecorded messages. Provide the ability to automatically repeat prerecorded messages. Provide a secure microphone for delivering live messages. Provide adequate discrete outputs to temporarily deactivate fire alarm audible notification, initiate/synchronize strobes and initiate textual visual notification appliances. Provide a complete set of self-diagnostics for controller and appliance network. Provide local diagnostic information display and local diagnostic information and system event log file.

2.3.1 Cabinet

Install control unit components in cabinets large enough to accommodate all components and also to allow ample gutter space for interconnection of control units as well as field wiring. The cabinet must be a sturdy steel housing, complete with back box, hinged steel door with cylinder lock, and semi-recessed mounting provisions. The enclosure must be identified by an engraved phenolic resin nameplate. Lettering on the nameplate must say "Fire Alarm and Mass Notification control unit" and must not be less than 1-inch high. Provide prominent rigid plastic or metal identification plates for lamps, circuits, meters, fuses, and switches.

2.3.2 Silencing Switches

2.3.2.1 Alarm Silencing Switch

Provide an alarm silencing switch at the FMCU that must silence the audible and visual notification appliances. Subsequent activation of initiating devices must cause the notification appliances to re-activate.

2.3.2.2 Supervisory/Trouble Silencing Switch

Provide supervisory and trouble silencing switch(es) that must silence the audible trouble and supervisory signal(s), but not extinguish the visual

indicator. This switch must be overridden upon activation of a subsequent supervisory or trouble condition. Audible trouble indication must resound automatically every 24 hours after the silencing feature has been operated if the supervisory or trouble condition still exists.

2.3.3 Non-Interfering

Power and supervise each circuit such that a signal from one device does not prevent the receipt of signals from any other device. Initiating devices must be manually reset by switch from the FMCU after the initiating device or devices have been restored to normal.

2.3.4 Audible Notification System

The Audible Notification System must comply with the requirements of **NFPA 72** for Emergency Voice/Alarm Communications System requirements, except as specified herein. The system must be a one-way, multi-channel voice notification system incorporating user selectability of a minimum eight distinct sounds for tone signaling, and the incorporation of a voice module for delivery of recorded messages. Audible appliances must produce a three-pulse temporal pattern for three cycles followed by a voice message that is repeated until the control unit is reset or silenced. **For carbon monoxide detector activation, audible appliances must produce a four-pulse temporal pattern for three cycles followed by a voice message that is repeated until the control unit is reset or silenced.** Automatic messages must be broadcast through speakers throughout the building/facility but not in stairs or elevator cabs. A live voice message must override the automatic audible output through use of a microphone input at the control unit or the LOC.

- a. When using the microphone, live messages must be broadcast throughout a selected floor or floors, or all call. The system must be capable of operating all speakers at the same time. The Audible Notification System must support Public Address (PA) paging for the facility. This must be accomplished with the provision of a separate microphone with a head unit that interfaces with the FMCU. The public address paging function must not override any fire alarm or mass notification functions. The microphone must be hand-held style. Hand-held microphones must be housed in a separate protective cabinet. The cabinet must be accessible without the use of a key. The location of the microphone(s) must be approved by the **Maxwell Fire Department Inspector**. Activation of the public address microphone must not initiate activation of visual notification appliances or LED text displays.
- b. The microprocessor must actively interrogate circuitry, field wiring, and digital coding necessary for the immediate and accurate rebroadcasting of the stored voice data into the appropriate amplifier input. Loss of operating power, supervisory power, or any other malfunction that could render the digitalized voice module inoperative must automatically cause the three-pulse temporal pattern to take over all functions assigned to the failed unit in the event an alarm is activated.

2.3.4.1 Outputs and Operational Modules

All outputs and operational modules must be fully supervised with on-board diagnostics and trouble reporting circuits. Provide form "C" contacts for system alarm and trouble conditions. Provide circuits for operation of

auxiliary appliance during trouble conditions. During a Mass Notification event, the control unit must not generate nor cause any trouble alarms to be generated with the Fire Alarm system.

2.3.4.2 Mass Notification

- a. The system must have the capability of utilizing an LOC with redundant controls of the FMCU. Notification Appliance Circuits (NAC) must be provided for the activation of strobe appliances. Audio output must be selectable for line level. A hand-held microphone must be provided and, upon activation, must take priority over any tone signal, recorded message or PA microphone operation in progress, while maintaining the strobe NAC circuit activation.
- b. The Mass Notification functions must override the manual or automatic fire alarm notification, and public address (PA) functions. Other fire alarm functions including transmission of a signal(s) to the fire department must remain operational. When a mass notification announcement is disengaged and a fire alarm condition still exists, the audible and visual notification appliances must resume activation for alarm conditions. The fire alarm message must be of lower priority than all other messages (except any "test" messages) and must not override any other messages.
- c. THE MAXWELL FIRE DEPARTMENT WILL SPECIFY THE EMERGENCY NOTIFICATION MESSAGES AND ALERT TONES THAT ARE REQUIRED FOR THE BUILDING. THE FIRE DEPARTMENT WILL ALSO PROVIDE THE PRE-RECORDED TEXT-TO-SPEECH EMERGENCY NOTIFICATION MESSAGES. THE CONTRACTOR SHALL PROVIDE THE REQUIREMENT ALERT TONES FOR EACH MESSAGE AND HAVE THE MESSAGES AND ALERT TONES PROGRAMMED INTO THE VOICE EVACUATION SYSTEM.

2.3.4.3 Installation-Wide Control

THE FACP/MNS SHALL PROVIDE POINT-TO-POINT REPORTING TO THE FIRE ALARM CONTROL PANEL (FACP). THE FACP SHALL IN TURN PROVIDE POINT-TO-POINT REPORTING TO THE MONACO D-21 CENTRAL RECEIVING STATION AT THE ECC LOCATED IN BUILDING 929 MAXWELL (FIRE DEPARTMENT DISPATCH). POINT REPORTING, ALSO KNOWN AS POINT-TO-POINT REPORTING, IS THE CAPABILITY TO RELAY THE STATUS OF EACH ADDRESSABLE DEVICE AND CERTAIN SYSTEM COMPONENTS SUCH AS SIGNAL LINE CIRCUITS (SLC) TO THE D-21 CENTRAL RECEIVING STATION IN REAL TIME. THE FACP/MNS SHALL BE COMPATIBLE WITH AND SHALL COMMUNICATE SEAMLESSLY WITH THE D-21 CENTRAL RECEIVING STATION, WITHOUT IMPAIRING OPERATIONAL FUNCTION OR RELIABILITY OF ANY EXISTING FACP OR MNS. USE OF INTERFACING RELAYS BETWEEN THE FACP AND COMMUNICATIONS TRANSCEIVER TO PROVIDE POINT OR ZONAL ALARM TROUBLE STATUS SHALL NOT BE PERMITTED.

2.3.5 Memory

Provide each control unit with non-volatile memory and logic for all functions. The use of long life batteries, capacitors, or other age-dependent devices must not be considered as equal to non-volatile processors, PROMS, or EPROMS.

2.3.6 Field Programmability

Provide control units and control units that are fully field programmable for both input and output of control, initiation, notification, supervisory, and trouble functions. The system program configuration must be menu driven. System changes must be password protected. Any

proprietary equipment and proprietary software needed by qualified technicians to implement future changes to the fire alarm system must be provided as part of this contract.

2.3.7 Input/Output Modifications

The FMCU must contain features that allow the bypassing of input devices from the system or the modification of system outputs. These control features must consist of a control unit mounted keypad. Any bypass or modification to the system must indicate a trouble condition on the FMCU.

2.3.8 Resetting

Provide the necessary controls to prevent the resetting of any alarm, supervisory, or trouble signal while the alarm, supervisory or trouble condition on the system still exists.

2.3.9 Walk Test

The FMCU must have a walk test feature. When using this feature, operation of initiating devices must result in limited system outputs, so that the notification appliances operate for only a few seconds and the event is indicated in the history log, but no other outputs occur.

2.3.10 History Logging

The control unit must have the ability to store a minimum of 400 events in a log. These events must be stored in a battery-protected memory and must remain in the memory until the memory is downloaded or cleared manually. Resetting of the control unit must not clear the memory.

2.3.11 Manual Access

An operator at the control unit, having a proper access level, must have the capability to manually access the following information for each initiating device.

- a. Primary status.
- b. Device type.
- c. Present average value.
- d. Present sensitivity selected.
- e. Detector range (normal, dirty).

2.3.12 Heat Detector Self-Test Routines

Automatic self-test routines must be performed on each detector that will functionally check detector sensitivity electronics and ensure the accuracy of the value being transmitted. Any detector that fails this test must indicate a trouble condition with the detector location at the control unit.

2.4 LOCAL OPERATING CONSOLES (LOC)

2.4.1 General

The LOC must consist of a remote microphone station incorporating a push-to-talk (PTT) hand-held microphone and system status indicators. The LOC must have the capability of being utilized to activate prerecorded messages. The unit must incorporate microphone override of any tone generation or recorded messages. The unit must be fully supervised from the FMCU. The housing for the LOC must not be lockable. The LOC must have public address capability with the provision of a separate microphone. The PA paging function must not override any alarm or notification functions. The PA microphone must be hand-held style. Hand-held microphones must be housed in a separate protective cabinet. The cabinet must be accessible without the use of a key. The location of the microphones must be approved by the [Maxwell AFB Fire Department](#). Activation of the PA microphone must not initiate activation of visual notification appliances or LED text displays. The PA paging function must not override any alarm or notification functions.

2.4.2 Multiple LOCs

When an installation has more than one LOC, the LOCs must be programmed to allow only one LOC to be available for paging or messaging at a time. Once one LOC becomes active, all other LOC's will have an indication that the system is busy (Amber Busy Light) and cannot be used at that time. This is to avoid two messages being given at the same time. It must be possible to override or lockout the LOC's from the FMCU.

2.5 AMPLIFIERS, PREAMPLIFIERS, [TONE GENERATORS](#)

Any amplifiers, preamplifiers, tone generators, [digitalized voice generators](#), and other hardware necessary for a complete, operational, textual audible circuit conforming to [NFPA 72](#) must be housed in a remote FMCU, terminal cabinet, or in the FMCU. Individual amplifiers must be 100 watts maximum.

2.5.1 Operation

The system must automatically operate and control all building speakers.

2.5.2 Construction

Amplifiers must utilize computer grade solid state components and must be provided with output protection devices sufficient to protect the amplifier against any transient up to 10 times the highest rated voltage in the system.

2.5.3 Inputs

Equip each system with separate inputs for the tone generator, digitalized voice driver and control unit mounted microphone Public Address Paging Function. Microphone inputs must be of the low impedance, balanced line type. Both microphone and tone generator input must be operational on any amplifier.

2.5.4 Tone Generator

The tone generator must produce a three-pulse temporal pattern and must be

constantly repeated until interrupted by either the digitalized voice message, the microphone input, or the alarm silence mode as specified. The tone generator must be single channel with an automatic backup generator per channel such that failure of the primary tone generator causes the backup generator to automatically take over the functions of the failed unit and also causes transfer of the common trouble relay. The tone generator must be provided with securely attached labels to identify the component as a tone generator and to identify the specific tone it produces.

2.5.5 Protection Circuits

Each amplifier must be constantly supervised for any condition that could render the amplifier inoperable at its maximum output. Failure of any component must cause illumination of a visual "amplifier trouble" indicator on the control unit, appropriate logging of the condition in the history log, and other actions for trouble conditions as specified.

2.6 MANUAL STATIONS

Provide metal or plastic, semi-flush or surface (as field conditions dictate) mounted, double-action, addressable manual stations, that are not subject to operation by jarring or vibration. Stations must be equipped with screw terminals for each conductor. Stations that require the replacement of any portion of the device after activation are not permitted. Stations must be finished in red with molded raised lettering operating instructions of contrasting color. The use of a key must be required to reset the station.

2.7 SMOKE DETECTORS

2.7.1 Spot Type Detectors

Provide addressable photoelectric smoke detectors as follows:

- a. Provide analog/addressable photoelectric smoke detectors utilizing the photoelectric light scattering principle for operation in accordance with UL 268. Smoke detectors must be listed for use with the FMCU.
- b. Provide self-restoring type detectors that do not require any readjustment after actuation at the FMCU to restore them to normal operation. The detector must have a visual indicator to show actuation.
- c. Vibration must have no effect on the detector's operation. Protect the detection chamber with a fine mesh metallic screen that prevents the entrance of insects or airborne materials. The screen must not inhibit the movement of smoke particles into the chamber.
- d. Provide twist lock bases (in dorm and sleeping rooms only) with sounder that produces a minimum of 90 dBA at 10 feet with screw terminals for each conductor. The detectors must maintain contact with their bases without the use of springs.
- e. The detector address must identify the particular unit, its location within the system, and its sensitivity setting. Detectors must be of the low voltage type rated for use on a 24 VDC system.

2.7.2 Duct Smoke Detectors

Duct-mounted addressable photoelectric smoke detectors must consist of a smoke detector, as specified in paragraph Spot Type Detectors, mounted in a special housing fitted with duct sampling tubes. Detector circuitry must be mounted in a metallic or plastic enclosure exterior to the duct. Detectors must be listed for operation over the complete range of air velocities, temperature and humidity expected at the detector when the air-handling system is operating. Detectors must be powered from the FMCU.

- a. Sampling tubes must run the full width of the duct. The duct detector package must conform to the requirements of NFPA 90A, UL 268A, and must be listed for use in air-handling systems. The control functions, operation, reset, and bypass must be controlled from the FMCU.
- b. Lights to indicate the operation and alarm condition must be visible and accessible with the unit installed and the cover in place. Remote indicators must be provided where required by NFPA 72. Remote indicators as well as the affected fan units must be properly identified in etched plastic placards.
- c. Detectors must provide for control of auxiliary contacts that provide control, interlock, and shutdown functions. Auxiliary contacts provide for this function must be located within 3 feet of the controlled circuit or appliance. The auxiliary contacts must be supplied by the fire alarm system manufacturer to ensure complete system compatibility.

2.8 HEAT DETECTORS

2.8.1 Heat Detectors

Heat detectors must be analog/addressable and designed for detection of fire by combination fixed temperature and rate-of-rise principle in accordance with UL 521. The alarm condition must be determined by comparing detector value with the stored values.. Detectors located in areas subject to moisture, exterior atmospheric conditions, or hazardous locations as defined by NFPA 70, must be types approved for such locations.

2.8.1.1 Fixed Temperature Detectors

Detectors must be semi-flush mounted in the horizontal orientation and supported independently of wiring connections. Detectors must be self-restoring. The detectors must have a specific temperature setting 135 degrees F. The detector assembly must be weatherproof only where indicated.

2.9 CARBON MONOXIDE DETECTOR

Analog/addressable carbon monoxide (CO) detectors must be listed to UL 2075 and set to respond to the sensitivity limits of UL 2034. Carbon monoxide detectors must be listed for use with fire alarm control units. Detectors must be semi-flush mounted in the horizontal orientation and supported independently of wiring connections. Detectors must be self-restoring. For FMCU with no listed compatible addressable CO detectors, provide listed 4-wire detectors. Do not provide CO detectors with local alarms. Detector must be provided with an LED status indicator.

- a. Where 4-wire CO detectors are necessary, each 4-wire CO detector must be individually monitored via addressable interface modules for alarm and off normal/trouble conditions (including loss of power to the individual detector). Power circuits for 4-wire CO detectors must be dedicated to powering the CO detectors only. Battery powered and 120 VAC powered detectors are prohibited.
- b. Wiring connections must be made by means of screw terminals and detectors must be equipped with trouble relays. Detectors must be able to mount a single-gang electrical box.
- c. A trouble condition at an individual CO detector must not affect any other CO detectors. CO detectors must be powered by the FMCU.
- d. Detectors must be provided with a means to test CO gas entry into the CO sensing cell.

2.10 ADDRESSABLE INTERFACE DEVICES

The initiating device being monitored must be configured as a Class "A" initiating device circuits. The module must be listed as compatible with the control unit. The module must provide address setting means compatible with the control unit's SLC supervision and store an internal identifying code. Monitor module must contain an integral LED that flashes each time the monitor module is polled and is visible through the device cover plate. Pull stations with a monitor module in a common backbox are not required to have an LED. Modules must be listed for the environmental conditions in which they will be installed.

2.11 ADDRESSABLE CONTROL MODULES

The control module must be capable of operating as a relay (dry contact form C) for interfacing the control unit with other systems, and to control door holders or initiate elevator fire service. The module must be listed as compatible with the control unit. The indicating device or the external load being controlled must be configured as Class A notification appliance circuits. The system must be capable of supervising, audible, visual and dry contact circuits. The control module must have both an input and output address. The supervision must detect a short on the supervised circuit and must prevent power from being applied to the circuit. The control module must provide address setting means compatible with the control unit's SLC supervision and store an internal identifying code. The control module must contain an integral LED that flashes each time the control module is polled and is visible through the device cover plate. Control Modules must be listed for the environmental conditions in which they will be installed.

2.12 NOTIFICATION APPLIANCES

2.12.1 Audible Notification Appliances

Audible appliances must conform to the applicable requirements of [UL 464](#). Appliances must be connected into notification appliance circuits. Surface mounted audible appliances must be painted [per UFC requirements](#). Recessed audible appliances must be installed with a grill that is painted [per UFC requirements](#) with a factory finish to match the surface to which it is mounted.

2.12.1.1 Speakers

- a. Speakers must conform to the applicable requirements of [UL 1480](#). Speakers must have six different sound output levels and operate with audio line input levels of 70.7 VRMs and 25 VRMs, by means of selectable tap settings. Interior speaker tap settings must include taps of 1/4, 1/2, 1, and 2 watt, at a minimum. Exterior speakers must also be multi-tapped with no more than 15 watt maximum setting. Speakers must incorporate a high efficiency speaker for maximum output at minimum power across a frequency range of 400 Hz to 4,000 Hz, and must have a sealed back construction. Speakers must be capable of installation on standard [4-inch](#) square electrical boxes. Where speakers and strobes are provided in the same location, they may be combined into a single wall mounted unit. All inputs must be polarized for compatibility with standard reverse polarity supervision of circuit wiring via the FMCU.
- b. Provide speaker mounting plates constructed of cold rolled steel having a minimum thickness of [16 gage](#) or molded high impact plastic and equipped with mounting holes and other openings as needed for a complete installation. Fabrication marks and holes must be ground and finished to provide a smooth and neat appearance for each plate. Each plate must be primed and painted.
- c. Speakers must utilize screw terminals for termination of all field wiring.

2.12.2 Visual Notification Appliances

Visual notification appliances must conform to the applicable requirements of [UL 1638](#), [UL 1971](#) and conform to the Architectural Barriers Act (ABA). Visual Notification Appliances must have clear high intensity optic lens, xenon flash tubes, or light emitting diode (LED) and be marked "Alert" in letters of contrasting color. The light pattern must be dispersed so that it is visible above and below the strobe and from a 90 degree angle on both sides of the strobe. Strobe flash rate must be 1 flash per second and a minimum of 30 candela based on the [UL 1971](#) test. Strobe must be semi-flush mounted.

2.12.3 Textual Display Signs

Textual display signs must be LED scrolling and must not exceed [16 inches long by 6 inches high by 3 inches deep](#) with a height necessary to meet the requirements of [NFPA 72](#). The text display must spell out the word "EVACUATE" or "ANNOUNCEMENT" and the remainder of the emergency instructions as appropriate. The design of text display must be such that it cannot be read when not illuminated.

LCD or LED scrolling text displays must meet the following requirements at a minimum:

- a. Two lines of information for high priority messaging.
- b. Minimum of 20 characters per line (40 total) displayed.
- c. Text must be no less than height requirements and color/contrast requirements of [NFPA 72](#).
- d. 32K character memory.

- e. Display must be wall or ceiling mounted.
- f. Mounting brackets for a convenient wall/cubicle mount.
- g. During non-emergency periods, display date and time.
- h. The system must interface with the [textual display sign control panel](#) to activate the proper message.

2.13 ELECTRIC POWER

2.13.1 Primary Power

Power must be 120 VAC 60 Hz service for the FMCU from the AC service to the building in accordance with [NFPA 72](#). [Where possible the contractor may re-connect to the existing power circuit previously serving the old Fire Alarm System.](#)

2.14 SECONDARY POWER SUPPLY

Provide for system operation in the event of primary power source failure. Transfer from normal to auxiliary (secondary) power or restoration from auxiliary to normal power must be automatic and must not cause transmission of a false alarm.

2.14.1 [Batteries](#)

Provide sealed, maintenance-free, sealed lead acid batteries as the source for emergency power to the FMCU. Batteries must contain suspended electrolyte. The battery system must be maintained in a fully charged condition by means of a solid state battery charger. Provide an automatic transfer switch to transfer the load to the batteries in the event of the failure of primary power.

2.14.1.1 Capacity

Battery size must be the greater of the following two capacities. This capacity applies to every control unit associated with this system, including [supplemental notification appliance circuit panels](#), [auxiliary power supply panels](#), fire alarm transmitters, and Base-wide mass notification transceivers. When determining the required capacity under alarm condition, visual notification appliances must include both textual and non-textual type appliances.

- a. Sufficient capacity to operate the fire alarm system under supervisory and trouble conditions, including audible trouble signal devices for 48 hours and audible and visual signal devices under alarm conditions for an additional 15 minutes.
- b. Sufficient capacity to operate the mass notification for 60 minutes after loss of AC power.

2.14.1.2 Battery Power Calculations

- a. Verify that battery capacity exceeds supervisory and alarm power requirements for the criteria noted in the paragraph "Capacity" above.

(1) Substantiate the battery calculations for alarm and supervisory

power requirements. Include ampere-hour requirements for each system component and each control unit component, and compliance with [UL 864](#).

- (2) Provide complete battery calculations for both the alarm and supervisory power requirements. Submit ampere-hour requirements for each system component with the calculations.
- (3) Provide voltage drop calculations to indicate that sufficient voltage is available for proper operation of the system and all components. Calculations must be performed using the minimum rated voltage of each component.

- b. For battery calculations assume a starting voltage of 24 VDC for starting the calculations to size the batteries. Calculate the required Amp-Hours for the specified standby time, and then calculate the required Amp-Hours for the specified alarm time. Using 20.4 VDC as starting voltage, perform a voltage drop calculation for circuits containing device and/or appliances remote from the power sources.

2.14.2 [Battery Chargers](#)

Provide a solid state, fully automatic, variable charging rate battery charger. The charger must be capable of providing 120 percent of the connected system load and must maintain the batteries at full charge. In the event the batteries are fully discharged (20.4 Volts dc), the charger must recharge the batteries back to 95 percent of full charge within 48 hours after a single discharge cycle as described in paragraph CAPACITY above. Provide pilot light to indicate when batteries are manually placed on a high rate of charge as part of the unit assembly if a high rate switch is provided.

2.15 SURGE PROTECTIVE DEVICES

[Surge protective devices](#) must be provided to suppress all voltage transients which might damage fire alarm control unit components. Systems having circuits located outdoors, communications equipment must be protected against surges induced on any signaling line circuit. Cables and conductors, that serve as communications links, must have surge protection circuits installed at each end. The surge protective device must wire in series to the power supply of the protected equipment with screw terminations. Line voltage surge arrestor must be installed directly adjacent to the power panel where the FMCU breaker is located.

- a. Surge protective devices for nominal 120 VAC must be [UL 1449](#) listed with a maximum 500 volt suppression level and have a maximum response time of 5 nanoseconds. The surge protective device must also meet [IEEE C62.41.1](#) and [IEEE C62.41.2](#) category B tests for surge capacity. The surge protective device must feature multi-stage construction and be provided with a long-life indicator lamp (either light emitting diode or neon) which extinguishes upon failure of protected components. Any unit fusing must be externally accessible.
- b. Surge protective devices for nominal 24 VAC, fire alarm telephone dialer, or ethernet connection must be [UL 497B](#) listed, meet [IEEE C62.41.1](#) and have a maximum response time of 1-nanosecond. The surge protective device must feature multi-stage construction and be self-resetting. The surge protective device must be a base and plug style. The base assembly must have screw terminals for fire [alarm](#)

wiring. The base assembly must accept "plug-in" surge protective module.

- c. All surge protective devices (SPD) must be the standard product of a single manufacturer and be equal or better than the following:
- (1) For 120 VAC nominal line voltage: **UL 1449** and **UL 1283** listed, series connected 120 VAC, 20A rated, surge protective device in a NEMA 4x enclosure. Minimum 50,000 amp surge current rating with EMI/RFI filtering and a dry contact circuit for remote monitoring of surge protection status.
 - (2) For 24-volt nominal line voltage: **UL 497B** listed, series connected low voltage, 24-volt, 5A rated, loop circuit protector, base and replaceable module.
 - (3) For alarm telephone dialers: **UL 497A** listed, series connected, 130-volt, 150 mA rated with self-resetting fuse, dialer circuit protector with modular plug and play.
 - (4) For IP-DACTS: **UL 497B** listed, series connected, 6.4-volt, 1.5A rated with 20 kA/pair surge current, data network protector with modular plug and play.

2.16 WIRING

Provide wiring materials under this section as specified in Section **26 20 00** INTERIOR DISTRIBUTION SYSTEM with the additions and modifications specified herein.

2.16.1 Alarm Wiring

IDC and SLC wiring must be solid copper cable in accordance with the manufacturers requirements. Copper signaling line circuits and initiating device circuit field wiring must be No. 14 AWG size conductors at a minimum. Visual notification appliance circuit conductors, that contain audible alarm appliances, must be copper No. 14 AWG size conductors at a minimum. Speaker circuits must be copper No. 16 AWG size twisted and shielded conductors at a minimum. Wiring for textual notification appliance circuits must be in accordance with manufacturer's requirements but must be supervised by the FMCU. Wire size must be sufficient to prevent voltage drop problems. Circuits operating at 24 VDC must not operate at less than the listed voltages for the detectors and/or appliances. Power wiring, operating at 120 VAC minimum, must be a minimum No. 12 AWG solid copper having similar insulation. Acceptable power-limited cables are FPL, FPLR or FPLP as appropriate with red colored covering. Nonpower-limited cables must comply with **NFPA 70**.

2.17 INTERFACE TO THE BASE-WIDE MASS NOTIFICATION NETWORK

THE FACP/MNS SHALL PROVIDE POINT-TO-POINT REPORTING TO THE FIRE ALARM CONTROL PANEL (FACP). THE FACP SHALL IN TURN PROVIDE POINT REPORTING TO THE MONACO D-21 CENTRAL RECEIVING STATION AT THE ECC LOCATED IN BUILDING 929 MAXWELL (FIRE DEPARTMENT DISPATCH). POINT REPORTING, ALSO KNOWN AS POINT-TO-POINT REPORTING, IS THE CAPABILITY TO RELAY THE STATUS OF EACH ADDRESSABLE DEVICE AND CERTAIN SYSTEM COMPONENTS SUCH AS SIGNAL LINE CIRCUITS (SLC) TO THE D-21 CENTRAL RECEIVING STATION IN REAL TIME. THE FACP/MNS SHALL BE COMPATIBLE WITH AND SHALL COMMUNICATE SEAMLESSLY WITH THE D-21 CENTRAL RECEIVING STATION, WITHOUT IMPAIRING OPERATIONAL FUNCTION OR RELIABILITY OF ANY EXISTING FACP OR MNS. USE OF INTERFACING RELAYS

BETWEEN THE FACP AND COMMUNICATIONS TRANSCEIVER TO PROVIDE POINT OR ZONAL ALARM TROUBLE STATUS SHALL NOT BE PERMITTED.

2.17.1 Radio

The mass notification transceiver must be bi-direction and meet all the requirements of paragraph, RADIO TRANSMITTER AND INTERFACE PANELS as specified in this specification section. The transceiver utilized in the mass notification system must be capable of the following:

- a. Communication with the central control/monitoring system to provide supervision of communication link and status changes are reported by automatic and manual poll/reply/acknowledge routines.
- b. All monitored points/status changes are transmitted immediately and at programmed intervals until acknowledged by the central control/monitoring system.
- c. Each transceiver must transmits a unique identity code as part of all messages; the code is set by the user at the transceiver.

2.18 AUTOMATIC FIRE ALARM TRANSMITTERS

2.18.1 Radio Transmitter and Interface Panels

Transmitters must be compatible with proprietary supervising station receiving equipment. Each radio alarm transmitter must be the manufacturer's recognized commercial product, completely assembled, wired, factory tested, and delivered ready for installation and operation. Transmitters must be provided in accordance with applicable portions of NFPA 72, Federal Communications Commission (FCC) 47 CFR 90 and Federal Communications Commission (FCC) 47 CFR 15. Transmitter electronics module must be contained within the physical housing as an integral, removable assembly. The proprietary supervising station receiving equipment is manufactured by Monaco and the transmitter must be fully compatible with this equipment. At the contractors option, and if listed, the transmitter may be housed in the same control unit as the FMCU. The transmitter must be narrowband radio, with FCC certification for narrowband operation and meets the requirements of the NTIA (National Telecommunications and Information Administration) Manual of Regulations and Procedures for Federal Frequency Management.

2.18.1.1 Operation

Operate each transmitter from 120-volt ac power. In the event of 120-volt ac power loss, the transmitter must automatically switch to battery operation. Switchover must be accomplished with no interruption of protective service, and must automatically transmit a trouble message. Upon restoration of ac power, transfer back to normal ac power supply must also be automatic.

2.18.1.2 Battery Power

Transmitter standby battery capacity must provide sufficient power to operate the transmitter in a normal standby status for a minimum of 72 hours and be capable of transmitting alarms during that period.

2.18.1.3 Transmitter Housing

Use NEMA Type 1 for housing. The housing must contain a lock that is

keyed identical to the fire alarm system for the building. Radio alarm transmitter housing must be factory painted with a suitable priming coat and not less than two coats of a hard, durable weatherproof enamel.

2.18.1.4 Antenna

Antenna must be omnidirectional, coaxial, halfwave dipole antennas for radio alarm transmitters with a driving point impedance to match transmitter output. The antenna and antenna mounts must be corrosion resistant and designed to withstand wind velocities of 100 mph. Do not mount antennas to any portion of the building roofing system. Protect the antenna from physical damage.

2.18.2 Signals to Be Transmitted to the Base Receiving Station

The following signals must be sent to the base receiving station:

- a. Sprinkler waterflow
- b. Manual pull stations
- c. Smoke detectors
- d. Duct smoke detectors
- e. Sleeping room smoke detectors
- f. Carbon monoxide detectors
- g. Heat detectors
- h. Fire extinguishing system
- i. Sprinkler valve supervision

2.19 SYSTEM MONITORING

2.19.1 Valves

Each valve affecting the proper operation of a fire protection system, including automatic sprinkler control valves, standpipe control valves, sprinkler service entrance valve, isolating valves for pressure type waterflow or supervision switches, and valves at backflow preventers, whether supplied under this contract or existing, must be electrically monitored to ensure its proper position. Provide each tamper switch with a separate address.

2.19.2 Electromagnetic Door Holders

Electromagnetic holding devices must operate on 24 VDC, and require not more than 3 watts of power to develop 25 psi of holding force. Under normal conditions, the magnets must attract and hold the doors open. Operation must be fail safe with no moving parts. Electromagnetic door hold-open devices must not be required to be held open during building power failure. The device must be listed based on UL 228 tests.

2.20 ENVIRONMENTAL ENCLOSURES OR GUARDS

Environmental enclosures must be provided to permit fire alarm/mass

notification components to be used in areas that exceed the environmental limits of the listing. The enclosure must be listed for the device or appliance as either a manufactured part number or as a listed compatible accessory for the component is currently listed. Guards required to deter mechanical damage must be either a listed manufactured part or a listed accessory for the category of the initiating device or notification appliance.

PART 3 EXECUTION

3.1 VERIFYING ACTUAL FIELD CONDITIONS

Before commencing work, examine all adjoining work on which the contractor's work is in any way dependent for perfect workmanship according to the intent of this specification section, and report to the Contracting Officer's Representative any condition which prevents performance of first class work. No "waiver of responsibility" for incomplete, inadequate or defective adjoining work will be considered unless notice has been filed before submittal of a proposal.

3.2 INSTALLATION

3.2.1 Fire Alarm and Mass Notification Control Unit (FMCU)

Locate the FMCU where indicated on the drawings. Semi-recess or Surface mount as field conditions dictate the enclosure with the top of the cabinet 6 feet above the finished floor or center the cabinet at 5 feet, whichever is lower. Conductor terminations must be labeled and a drawing containing conductors, their labels, their circuits, and their interconnection must be permanently mounted in the FMCU. Locate the document storage cabinet adjacent to the FMCU unless the Contracting Officer directs otherwise.

3.2.2 Battery Cabinets

When batteries will not fit in the FMCU, locate battery cabinets below or adjacent to the FMCU. Battery cabinets must be installed at an accessible location when standing at floor level. Battery cabinets must not be installed lower than 12 inches above finished floor, measured to the bottom of the cabinet, nor higher than 36 inches above the floor, measured to the top of the cabinet. Installing batteries above drop ceilings or in inaccessible locations is prohibited. Battery cabinets must be large enough to accommodate batteries and also to allow ample gutter space for interconnection of control units as well as field wiring. The cabinet must be provided in a sturdy steel housing, complete with back box, hinged steel door with cylinder lock, and surface mounting provisions. The cabinet must be identified by an engraved phenolic resin nameplate. Lettering on the nameplate must indicate the control unit(s) the batteries power and must not be less than 1-inch high.

3.2.3 Manual Stations

Locate manual stations as required by NFPA 72 and as indicated on the drawings. Mount stations so they are located no farther than 5 feet from the exit door they serve, measured horizontally. Manual stations must be mounted at 42 inches measured to the operating handle.

3.2.4 Notification Appliances

- a. Locate notification appliance devices where indicated and to meet the intelligibility requirements. Where two or more visual notification appliances are located in the same room or corridor or field of view, provide synchronized operation. Devices must use screw terminals for all field wiring. Audible and visual notification appliances mounted in acoustical ceiling tiles must be centered in the tiles plus or minus 2 inches.
- b. Audible and visual notification appliances mounted on the exterior of the building, within unconditioned spaces, or in the vicinity of showers must be listed weatherproof appliances installed on weatherproof backboxes.
- c. Speakers must not be located in close proximity to the FMCU or LOC so as to cause feedback when the microphone is in use.

3.2.5 Smoke and Heat Detectors

Locate detectors as indicated on the drawings on a 4-inch mounting box. Install heat detectors not less than 4 inches from a side wall to the near edge. Heat detectors located on the wall must have the top of the detector at least 4 inches below the ceiling, but not more than 12 inches below the ceiling. Smoke detectors are permitted to be on the wall no lower than 12 inches from the ceiling with no minimum distance from the ceiling. In raised floor spaces, install the smoke detectors to protect 225 square feet per detector. Install smoke detectors no closer than 3 feet from air handling supply diffusers. Detectors installed in acoustical ceiling tiles must be centered in the tiles plus or minus 2 inches.

3.2.6 Carbon Monoxide Detectors

Locate detectors as indicated on the drawings on a 4-inch mounting box. Carbon monoxide detectors must be installed separate from smoke and/or heat detectors.

3.2.7 LCD REMOTE Annunciator

Locate the LCD annunciator as shown on the drawings. Mount the annunciator, with the top 6 feet above the finished floor or center the annunciator at 5 feet, whichever is lower.

3.2.8 Electromagnetic Door Holder Release

Doors must be held open at a minimum of 90 degrees so as not to impede egress from the space. Mount the armature portion on the door and have an adjusting screw for seating the angle of the contact plate. Wall-mount the electromagnetic release, with a total horizontal projection not exceeding 4 inches. Ensure all doors release to close upon first stage (pre-discharge) alarm. Electrical supervision of wiring external of control unit for magnetic door holding circuits is not required.

3.2.9 Local Operating Console (LOC)

Locate the LOC(s) as required by NFPA 72 and as indicated. Mount the console so that the top message button and microphone is no higher than 4 feet above the floor and the bottom (lowest) message button and microphone

is at least 3 feet above the finished floor.

3.2.10 Ceiling Bridges

Provide ceiling bridges for ceiling-mounted appliances. Ceiling bridges must be as recommended/required by the manufacturer of the ceiling-mounted notification appliance.

3.3 SYSTEM FIELD WIRING

3.3.1 Wiring within Cabinets, Enclosures, and Boxes

Provide wiring installed in a neat and workmanlike manner and installed parallel with or at right angles to the sides and back of any box, enclosure, or cabinet. Conductors that are terminated, spliced, or otherwise interrupted in any enclosure, cabinet, mounting, or junction box must be connected to screw-type terminal blocks. Mark each terminal in accordance with the wiring diagrams of the system. The use of wire nuts or similar devices is prohibited. Wiring to conform with NFPA 70.

Indicate the following in the wiring diagrams:

- a. Point-to-point wiring diagrams showing the points of connection and terminals used for electrical field connections in the system, including interconnections between the equipment or systems that are supervised or controlled by the system. Diagrams must show connections from field devices to the FMCU and remote fire alarm/mass notification control units, initiating circuits, switches, relays and terminals.
- b. Complete riser diagrams indicating the wiring sequence of devices and their connections to the control equipment. Include a color code schedule for the wiring. Include floor plans showing the locations of devices and equipment.

3.3.2 Terminal Cabinets

Provide a terminal cabinet at the base of any circuit riser, on each floor at each riser, and where indicated on the drawings. Terminal size must be appropriate for the size of the wiring to be connected. Conductor terminations must be labeled and a drawing containing conductors, their labels, their circuits, and their interconnection must be permanently mounted in the terminal cabinet. Minimum size is 8 inches by 8 inches. Only screw-type terminals are permitted. Provide an identification label, that displays "FIRE ALARM TERMINAL CABINET" with 2-inch lettering, on the front of the terminal cabinet.

3.3.3 Alarm Wiring

- a. Voltages must not be mixed in any junction box, housing or device, except those containing power supplies and control relays.
- b. Utilize shielded wiring where recommended by the manufacturer. For shielded wiring, ground the shield at only one point, in or adjacent to the FMCU.
- c. Color coding is required for circuits and must be maintained throughout the circuit. Conductors used for the same functions must be similarly color coded. Conform wiring to NFPA 70.

- d. Pull all conductors splice free. The use of wire nuts, crimped connectors, or twisting of conductors is prohibited. Where splices are unavoidable, the location of the junction box or pull box where they occur must be identified on the as-built drawings. The number and location of splices must be subject to approval by the Designated Fire Protection Engineer (DFPE).

3.3.4 Back Boxes and Conduit

In addition to the requirements of Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM, provide all wiring in rigid metal conduit or intermediate metal conduit unless specifically indicated otherwise. Minimum conduit size must be 3/4-inch in diameter. Do not use electrical non-metallic tubing (ENT) or flexible non-metallic tubing and associated fittings.

- a. Galvanized rigid steel (GRS) conduit must be utilized where exposed to weather, where subject to physical damage, and where exposed on exterior of buildings. Intermediate metal conduit (IMC) may be used in lieu of GRS as allowed by NFPA 70.
- b. Electrical metallic tubing (EMT) is permitted above suspended ceilings or exposed where not subject to physical damage. Do not use EMT underground, encased in concrete, mortar, or grout, in hazardous locations, where exposed to physical damage, outdoors or in fire pump rooms. Use die-cast compression connectors.
- c. For rigid metallic conduit (RMC), only threaded type fitting are permitted for wet or damp locations.
- d. Flexible metal conduit is permitted for initiating device circuits 6 feet in length or less. Flexible metal conduit is prohibited for notification appliance circuits and signaling line circuits. Use liquid tight flexible metal conduit in damp and wet locations.
- e. Schedule 40 (minimum) polyvinyl chloride (PVC) is permitted where conduit is routed underground or underground below floor slabs. Convert non-metallic conduit, other than PVC Schedule 40 or 80, to plastic-coated rigid, or IMC, steel conduit before turning up through floor slab.
- f. Exterior wall penetrations must be weathertight. Conduit must be sealed to prevent the infiltration of moisture.
- g. For Class "A" circuits with conductor lengths of 10 feet or less, the conductors must be permitted to be installed in the same raceway in accordance with NFPA 72.

3.3.5 Conductor Terminations

Labeling of conductors at terminal blocks in terminal cabinets, FMCU and the LOC must be provided at each conductor connection. Each conductor or cable must have a shrink-wrap label to provide a unique and specific designation. Each terminal cabinet, FMCU, and remote FMCU must contain a laminated drawing that indicates each conductor, its label, circuit, and terminal. The laminated drawing must be neat, using 12 point lettering minimum size, and mounted within each cabinet, control unit, or unit so that it does not interfere with the wiring or terminals. Maintain existing color code scheme where connecting to existing equipment.

3.4 DISCONNECTION AND REMOVAL OF EXISTING SYSTEM

Maintain existing fire alarm/mass notification equipment fully operational until the new equipment has been tested and accepted by the Contracting Officer. As new equipment is installed, label it "NOT IN SERVICE" until the new equipment is accepted. Once the new system is completed, tested, and accepted by the Government, it must be placed in service and connected to the supervising station. Remove tags from new equipment and tag the existing equipment "NOT IN SERVICE" until removed from the building.

- a. After acceptance of the new system by the Contracting Officer, remove existing equipment not connected to the new system, remove unused exposed conduit, and restore damaged surfaces. Remove the material from the site and dispose.
- b. Disconnect and remove the existing fire alarm/mass notification and smoke detection systems where indicated and elsewhere in the specification.
- c. Control units and fire alarm devices and appliances disconnected and removed must be turned over to the Contracting Officer.
- d. Properly dispose of fire alarm outlet and junction boxes, wiring, conduit, supports, and other such items.

3.5 CONNECTION OF NEW SYSTEM

The following new system connections must be made during the last phase of construction, at the beginning of the pre-Government tests. New system connections must include:

- a. Connection of new relays to existing magnetic door hold-open devices.
- b. Connection of new elevator recall relays to existing wiring and conduit.
- c. Connection of new system transmitter to existing installation fire reporting system.

Once these connections are made, system must be left energized. Report immediately to the Contracting Officer, coordination and field problems resulting from the connection of the above components.

3.6 FIRESTOPPING

Provide firestopping for holes at conduit penetrations through floor slabs, fire-rated walls, partitions with fire-rated doors, corridor walls, and vertical service shafts in accordance with Section 07 84 00 FIRESTOPPING.

3.7 PAINTING

- a. In unfinished areas (including areas above drop ceilings), paint all exposed electrical conduit (serving fire alarm equipment), fire alarm conduit, surface metal raceway, junction boxes and covers red. In lieu of painting conduit, the contractor may utilize red conduit with a factory applied finish.

- b. In finished areas, paint exposed electrical conduit (serving fire alarm equipment), fire alarm conduit, surface metal raceways, junction boxes, and electrical boxes to match adjacent finishes. The inside cover of the junction box must be identified as "Fire Alarm" and the conduit must have painted red bands $\frac{3}{4}$ -inch wide at 10-foot centers and at each side of a floor, wall, or ceiling penetration.
- c. Painting must comply with Section 09 90 00 PAINTS AND COATINGS.

3.8 FIELD QUALITY CONTROL

3.8.1 Test Procedures

Submit detailed test procedures, prepared and signed by the NICET Level IV Fire Alarm Technician, and the representative of the installing company, 60 days prior to performing system tests. Detailed test procedures must list all components of the installed system such as initiating devices and circuits, notification appliances and circuits, signaling line devices and circuits, control devices/equipment, batteries, transmitting and receiving equipment, power sources/supply, annunciators, special hazard equipment, emergency communication equipment, interface equipment, and surge protective devices. Test procedures must include sequence of testing, time estimate for each test, and sample test data forms. The test data forms must be in a check-off format (pass/fail with space to add applicable test data; similar to the forms in NFPA 72 and NFPA 4.) The test procedures and accompanying test data forms must be used for the pre-Government testing and the Government testing. The test data forms must record the test results and must:

- a. Identify the NFPA Class of all Initiating Device Circuits (IDC), and Notification Appliance Circuits (NAC), Voice Notification System Circuits (NAC Audio), and Signaling Line Circuits (SLC).
- b. Identify each test required by NFPA 72 Test Methods and required test herein to be performed on each component, and describe how these tests must be performed.
- c. Identify each component and circuit as to type, location within the facility, and unique identity within the installed system. Provide necessary floor plan sheets showing each component location, test location, and alphanumeric identity.
- d. Identify all test equipment and personnel required to perform each test (including equipment necessary for smoke detector testing. The use of magnets is not permitted.
- e. Provide space to identify the date and time of each test. Provide space to identify the names and signatures of the individuals conducting and witnessing each test.

3.8.2 Pre-Government Testing

3.8.2.1 Verification of Compliant Installation

Conduct inspections and tests to ensure that devices and circuits are functioning properly. Tests must meet the requirements of paragraph entitled "Minimum System Tests" as required by NFPA 72. The contractor and an authorized representative from each supplier of equipment must be in attendance at the pre-Government testing to make necessary

adjustments. After inspection and testing is complete, provide a signed [Verification of Compliant Installation](#) letter by the QFPE that the installation is complete, compliant with the specification and fully operable. The letter must include the names and titles of the witnesses to the pre-Government tests. Provide all completion documentation as required by [NFPA 72](#) including all referenced annex sections and the test reports noted below.

- a. [NFPA 72](#) Record of Completion.
- b. [NFPA 72](#) Record of Inspection and Testing.
- c. Fire Alarm and Emergency Communication System Inspection and Testing Form.
- d. Audibility test results with marked-up test floor plans.
- e. Intelligibility test results with marked-up floor plans.
- f. Documentation that all tests identified in the paragraph "Minimum System Tests" are complete.

3.8.2.2 [Request for Government Final Test](#)

When the verification of compliant installation has been completed, submit a formal request for Government final test to the Contracting Officer's Representative (COR). Government final testing will not be scheduled until the DFPE has received copies of the request for Government final testing and Verification of Compliant Installation letter with all required reports. Government final testing will not be performed until after the connections to the installation-wide fire reporting system and the installation-wide mass notification system have been completed and tested to confirm communications are fully functional. Submit request for test at least 15 calendar days prior to the requested test date.

3.8.3 Correction of Deficiencies

If equipment was found to be defective or non-compliant with contract requirements, perform corrective actions and repeat the tests. Tests must be conducted and repeated if necessary until the system has been demonstrated to comply with all contract requirements.

3.8.4 Government Final Tests

The tests must be performed in accordance with the approved test procedures in the presence of the DFPE. Furnish instruments and personnel required for the tests. The following must be provided at the job site for Government Final Testing:

- a. The manufacturer's technical representative.
- c. Marked-up red line drawings of the system as actually installed.
- d. Loop resistance test results.
- e. Complete program printout including input/output addresses.
- f. Copy of pre-Government Test Certificate, test procedures and completed test data forms.

- g. Audibility test results with marked-up floor plans.
- h. Intelligibility test results with marked-up floor plans.

Government Final Tests will be witnessed by the Contracting Officer's Representative (COR) and the Maxwell Fire Department. At this time, any and all required tests noted in the paragraph "Minimum System Tests" must be repeated at their discretion.

3.9 MINIMUM SYSTEM TESTS

3.9.1 System Tests

Test the system in accordance with the procedures outlined in NFPA 72. The required tests are as follows:

- a. Loop Resistance Tests: Measure and record the resistance of each circuit with each pair of conductors in the circuit short-circuited at the farthest point from the circuit origin. The tests must be witnessed by the Contracting Officer and test results recorded for use at the final Government test.
- b. Verify the absence of unwanted voltages between circuit conductors and ground. The tests must be accomplished at the pre-Government test with results available at the final system test.
- c. Verify that the control unit is in the normal condition as detailed in the manufacturer's O&M manual.
- d. Test each initiating device and notification appliance and circuit for proper operation and response at the control unit. Smoke detectors must be tested in accordance with manufacturer's recommended calibrated test method. Use of magnets is prohibited. Testing of duct smoke detectors must comply with the requirements of NFPA 72 except disconnect at least 20 percent of devices. If there is a failure at these devices, then supervision must be tested at each device.
- e. Carbon Monoxide Detector Tests: Carbon monoxide detectors must be tested in accordance with NFPA 72 and the manufacturer's recommended calibrated test method.
- f. Test the system for specified functions in accordance with the contract drawings and specifications and the manufacturer's O&M manual.
- g. Test both primary power and secondary power. Verify, by test, the secondary power system is capable of operating the system for the time period and in the manner specified.
- h. Determine that the system is operable under trouble conditions as specified.
- i. Visually inspect wiring.
- j. Test the battery charger and batteries.
- k. Verify that software control and data files have been entered or programmed into the FMCU. Hard copy records of the software must be provided to the Contracting Officer.

- l. Verify that red-line drawings are accurate.
- m. Measure the current in circuits to ensure there is the calculated spare capacity for the circuits.
- n. Measure voltage readings for circuits to ensure that voltage drop is not excessive.
- o. Disconnect the verification feature for smoke detectors during tests to minimize the amount of smoke needed to activate the sensor. Testing of smoke detectors must be conducted using real smoke or the use of canned smoke which is permitted.
- p. Measure the voltage drop at the most remote appliance (based on wire length) on each notification appliance circuit.
- q. Verify the documentation cabinet is installed and contains all as-built shop drawings, product data sheets, design calculations, site-specific software data package, and all documentation required by paragraph titled "Test Reports".

3.9.2 Audibility Tests

Sound pressure levels from audible notification appliances must be a minimum of 15 dBa over ambient with a maximum of 110 dBa in any occupiable area. The provisions for audible notification (audibility and intelligibility) must be met with doors, fire shutters, movable partitions, and similar devices closed.

3.9.3 Intelligibility Tests

Intelligibility testing of the System must be accomplished in accordance with NFPA 72 for Voice Evacuation Systems, and ASA S3.2. Following are the specific requirements for intelligibility tests:

- a. Intelligibility Requirements: Verify intelligibility by measurement after installation.
- b. Ensure that a CIS value greater than the required minimum value is provided in each area where building occupants typically could be found. The minimum required value for CIS is .7. Rounding of values is permitted.
- c. Areas of the building provided with hard wall and ceiling surfaces (such as metal or concrete) that are found to cause excessive sound reflections may be permitted to have a CIS score less than the minimum required value if approved by the DFPE, and if building occupants in these areas can determine that a voice signal is being broadcast and they must walk no more than 33 feet to find a location with at least the minimum required CIS value within the same area.
- d. Areas of the building where occupants are not expected to be normally present are permitted to have a CIS score less than the minimum required value if personnel can determine that a voice signal is being broadcast and they must walk no more than 50 feet to a location with at least the minimum required CIS value within the same area.
- e. Take measurements near the head level applicable for most personnel in

the space under normal conditions (e.g., standing, sitting, sleeping, as appropriate).

- f. The distance the occupant must walk to the location meeting the minimum required CIS value must be measured on the floor or other walking surface as follows:
 - (1) Along the centerline of the natural path of travel, starting from any point subject to occupancy with less than the minimum required CIS value.
 - (2) Curving around any corners or obstructions, with a 12 inches clearance there from.
 - (3) Terminating directly below the location where the minimum required CIS value has been obtained.

Use commercially available test instrumentation to measure intelligibility as specified by NFPA 72 as applicable. Use the mean value of at least three readings to compute the intelligibility score at each test location.

3.10 SYSTEM ACCEPTANCE

Following acceptance of the system, as-built drawings and O&M manuals must be delivered to the Contracting Officer for review and acceptance. The drawings must show the system as installed, including deviations from both the project drawings and the approved shop drawings. These drawings must be submitted within two weeks after the final Government test of the system. At least one set of as-built (marked-up) drawings must be provided at the time of, or prior to the Final Government Test.

- a. The drawings must be prepared electronically and sized no less than the contract drawings. Furnish one set of CDs or DVDs containing software back-up and CAD based drawings in latest version of AutoCAD format .
- b. Include complete wiring diagrams showing connections between devices and equipment, both factory and field wired.
- c. Include a riser diagram and drawings showing the as-built location of devices and equipment.
- d. Provide Operation and Maintenance (O&M) Instructions.

In existing buildings, the transfer of devices from the existing system to the new system and the permission to begin demolition of the old fire alarm system will not be permitted until the as-built drawings and O&M manuals are received.

3.11 INSTRUCTION OF GOVERNMENT EMPLOYEES

3.11.1 Instructor

Provide the services of an instructor, who has received specific training from the manufacturer for the training of other persons regarding the operation, inspection, testing, and maintenance of the system provided. The instructor must train the Government employees designated by the Contracting Officer, in the care, adjustment, maintenance, and operation of the fire alarm system. The instructor must be thoroughly familiar with

all parts of this installation. The instructor must be trained in operating theory as well as in practical O&M work. Submit the instructors information and qualifications including the training history.

3.11.2 Required Instruction Time

Provide 8 hours of instruction after final acceptance of the system. The instruction must be given during regular working hours on such dates and times selected by the Contracting Officer. The instruction may be divided into two or more periods at the discretion of the Contracting Officer. The training must allow for rescheduling for unforeseen maintenance and/or fire department responses.

3.11.2.1 Technical Training

Equipment manufacturer or a factory representative must provide 1 days of on site. Training must allow for classroom instruction as well as individual hands on programming, troubleshooting and diagnostics exercises. Factory training must occur within 6 months of system acceptance.

3.11.3 Technical Training Manual

Provide, in manual format, lesson plans, operating instructions, maintenance procedures, and training data for the training courses. The operations training must familiarize designated government personnel with proper operation of the installed system. The maintenance training course must provide the designated government personnel adequate knowledge required to diagnose, repair, maintain, and expand functions inherent to the system.

3.12 EXTRA MATERIALS

3.12.1 Repair Service/Replacement Parts

Repair services and replacement parts for the system must be available for a period of 10 years after the date of final acceptance of this work by the Contracting Officer. During the warranty period, the service technician must be on-site within 24 hours after notification. All repairs must be completed within 24 hours of arrival on-site.

During the warranty period, the installing fire alarm contractor is responsible for conducting all required testing and maintenance in accordance with the requirements and recommended practices of NFPA 72 and the system manufacturers. Installing fire alarm contractor is NOT responsible for any damage resulting from abuse, misuse, or neglect of equipment by the end user.

3.12.2 Spare Parts

Spare parts furnished must be directly interchangeable with the corresponding components of the installed systems. Spare parts must be suitably packaged and identified by nameplate, tagging, or stamping. Spare parts must be delivered to the Contracting Officer at the time of the Government testing and must be accompanied by an inventory list.

3.12.3 Document Storage Cabinet

Upon completion of the project, but prior to project close-out, place in the document storage cabinet copies of the following record documentation:

- a. As-built shop drawings in PDF format and a DVD disc with the As-Built drawings in AutoCAD (DWG format).
- b. Product data sheets of each piece of equipment or devices used on the project along with manuals of all equipment used on the project.
- c. Design calculations
- d. Site-specific software data package
- e. All documentation required by SD-06.

-- End of Section --

SECTION 31 00 00

EARTHWORK

08/08, CHG 2: 02/21

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D698 (2012; E 2014; E 2015) Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/cu. ft. (600 kN-m/cu. m.))

ASTM D2487 (2017; E 2020) Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)

1.2 SYSTEM DESCRIPTION

Site Conditions: Verify visible conditions prior to bidding and accept site as found. Assume indicated existing topography is approximate only.

1.2.1 Classification of Excavation

No consideration will be given to the nature of the materials, and all excavation will be designated as unclassified excavation.

1.2.1.1 Common Excavation

Include common excavation with the satisfactory removal and disposal of all materials.

1.2.2 Blasting

Blasting will not be permitted.

1.3 SUBMITTALS

Government approval is required for submittals. Submit the following in accordance with Section **01 33 00** SUBMITTAL PROCEDURES:

SD-03 Product Data

Utilization of Excavated Materials

PART 2 PRODUCTS

2.1 Backfill

Utilize soil removed from excavation but free of rubbish and vegetable

matter. Place and compact as required to prevent settlement and avoid damage to other work. Do not place against retaining or foundation walls until slab is poured to support top of wall, concrete has reached design strength, waterproofing is approved, and/or other design considerations have been met.

2.2 BURIED WARNING AND IDENTIFICATION TAPE

Provide polyethylene plastic or metallic core or metallic-faced, acid- and alkali-resistant, polyethylene plastic warning tape manufactured specifically for warning and identification of buried utility lines. Provide tape on rolls, 3 inches minimum width, color coded as specified below for the intended utility with warning and identification imprinted in bold black letters continuously over the entire tape length. Warning and identification to read, "CAUTION, BURIED (intended service) LINE BELOW" or similar wording. Provide permanent color and printing, unaffected by moisture or soil.

Warning Tape Color Codes	
Red	Electric
Yellow	Gas, Oil; Dangerous Materials
Orange	Telephone and Other Communications
Blue	Water Systems
Green	Sewer Systems
White	Steam Systems
Gray	Compressed Air

2.3 MATERIAL FOR Bedding Material

Provide Bedding material conforming to these requirements for construction indicated.

2.3.1 Bedding Material

A. Fill Under Slabs: Employ suitable material removed from excavation, supplemented with sand-clay-gravel. Place in 8 inch layers and compact with power equipment to not less than 95 percent compaction per ASTM D698. Compact final 12 inches to 100 percent. Secure laboratory compaction tests of each lift at the rate of one test per 400 sf. Do not allow placement of fill to exceed 16" above an approved layer.

B. Porous Fill Under Slabs: 5 inch layer of washed gravel.

PART 3 EXECUTION

3.1 STRIPPING OF TOPSOIL

Where indicated or directed, strip topsoil to a depth of 4 inches. Spread topsoil on areas already graded and prepared for topsoil, or transported

and deposited in stockpiles convenient to areas that are to receive application of the topsoil later, or at locations indicated or specified. Keep topsoil separate from other excavated materials, brush, litter, objectionable weeds, roots, stones larger than 2 inches in diameter, and other materials that would interfere with planting and maintenance operations. Stockpile in locations indicated any surplus of topsoil from excavations and gradings.

3.2 GENERAL EXCAVATION

Perform excavation of every type of material encountered within the limits of the project to the lines, grades, and elevations indicated and as specified. Perform the grading in accordance with the typical sections shown and the tolerances specified in paragraph FINISHING. Transport satisfactory excavated materials and place in fill or embankment within the limits of the work. Excavate unsatisfactory materials encountered within the limits of the work below grade and replace with satisfactory materials as directed. Include such excavated material and the satisfactory material ordered as replacement in excavation. Dispose surplus satisfactory excavated material not required for fill and unsatisfactory excavated material as specified in paragraph DISPOSITION OF SURPLUS MATERIAL. During construction, perform excavation and fill in a manner and sequence that will provide proper drainage at all times. Excavate material required for fill or embankment in excess of that produced by excavation within the grading limits from other approved areas selected by the Contractor as specified.

3.2.1 Ditches, Gutters, and Channel Changes

Finish excavation of ditches, gutters, and channel changes by cutting accurately to the cross sections, grades, and elevations shown on the Drawings. Do not excavate ditches and gutters below grades shown. Backfill the excessive open ditch or gutter excavation with satisfactory, thoroughly compacted, material or with suitable stone or cobble to grades shown. Dispose excavated material as shown or as directed, except in no case allow material be deposited a maximum 4 feet from edge of a ditch. Maintain excavations free from detrimental quantities of leaves, brush, sticks, trash, and other debris until final acceptance of the work.

3.2.2 Drainage Structures

Make excavations to the lines, grades, and elevations shown, or as directed. Provide trenches and foundation pits of sufficient size to permit the placement and removal of forms for the full length and width of structure footings and foundations as shown. Clean rock or other hard foundation material of loose debris and cut to a firm, level, stepped, or serrated surface. Remove loose disintegrated rock and thin strata. Do not disturb the bottom of the excavation when concrete or masonry is to be placed in an excavated area. Do not excavate to the final grade level until just before the concrete or masonry is to be placed. Where pile foundations are to be used, stop the excavation of each pit at an elevation 1 foot above the base of the footing, as specified, before piles are driven. After the pile driving has been completed, remove loose and displaced material and complete excavation, leaving a smooth, solid, undisturbed surface to receive the concrete or masonry.

3.2.3 Drainage

Provide for the collection and disposal of surface and subsurface water

encountered during construction. Completely drain construction site during periods of construction to keep soil materials sufficiently dry. Construct storm drainage features (ponds/basins) at the earliest stages of site development, and throughout construction grade the construction area to provide positive surface water runoff away from the construction activity or provide temporary ditches, swales, and other drainage features and equipment as required to maintain dry soils. When unsuitable working platforms for equipment operation and unsuitable soil support for subsequent construction features develop, remove unsuitable material and provide new soil material as specified herein. It is the responsibility of the Contractor to assess the soil and ground water conditions presented by the plans and specifications and to employ necessary measures to permit construction to proceed.

3.2.4 Footing Trenches

Carefully cut and shape to depth indicated; step at changes in elevation. Protect from water damage. Bottom of footings must rest on natural undisturbed soil. Notify Architect of any inconsistency encountered in bearing soil.

3.2.5 Underground Utilities

The Contractor is responsible for movement of construction machinery and equipment over pipes and utilities during construction. Excavation made with power-driven equipment is not permitted within 2 feet of known Government-owned utility or subsurface construction. For work immediately adjacent to or for excavations exposing a utility or other buried obstruction, excavate by hand. Start hand excavation on each side of the indicated obstruction and continue until the obstruction is uncovered or until clearance for the new grade is assured. Support uncovered lines or other existing work affected by the contract excavation until approval for backfill is granted by the Contracting Officer. Report damage to utility lines or subsurface construction immediately to the Contracting Officer.

3.2.6 Uncovered Utilities

Unless shown otherwise, remove from building area and five feet beyond, including all inactive lines within 12 inches of finish grade. Seal and cap all lines to be abandoned. Protect any lines encountered in yard area and which are to remain active. If relocation is required for any line not indicated, notify the Contracting Officer for a cost adjustment.

Before proceeding with excavation, trenching, stump removal, etc., arrange with various utility companies to visit site and describe any and all of their systems which might be damaged by construction operations.

3.3 GRADING AREAS

Provide all grading work required for and during construction, grading required to prevent water drainage problems during construction, and grading of all areas within ten feet of the building, walk and drive

Where indicated, divide work into grading areas within which satisfactory excavated material will be placed in embankments, fills, and required backfills. Do not haul satisfactory material excavated in one grading area to another grading area except when so directed in writing. Place and grade stockpiles of satisfactory and unsatisfactory and wasted materials as specified. Keep stockpiles in a neat and well drained

condition, giving due consideration to drainage at all times. Clear, grub, and seal by rubber-tired equipment, the ground surface at stockpile locations; separately stockpile excavated satisfactory and unsatisfactory materials. Protect stockpiles of satisfactory materials from contamination which may destroy the quality and fitness of the stockpiled material. If the Contractor fails to protect the stockpiles, and any material becomes unsatisfactory, remove and replace such material with satisfactory material from approved sources.

3.4 FINAL GRADE OF SURFACES TO SUPPORT CONCRETE

Do not excavate to final grade until just before concrete is to be placed. Only use excavation methods that will leave the foundation rock in a solid and unshattered condition. Roughen the level surfaces, and cut the sloped surfaces, as indicated, into rough steps or benches to provide a satisfactory bond. Protect shales from slaking and all surfaces from erosion resulting from ponding or water flow.

3.5 GROUND SURFACE PREPARATION

3.5.1 General Requirements

Remove and replace unsatisfactory material with satisfactory materials, as directed by the Contracting Officer, in surfaces to receive fill or in excavated areas. Scarify the surface to a depth of 6 inches before the fill is started. Plow, step, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so that the fill material will bond with the existing material. When subgrades are less than the specified density, break up the ground surface to a minimum depth of 6 inches, pulverizing, and compacting to the specified density. When the subgrade is part fill and part excavation or natural ground, scarify the excavated or natural ground portion to a depth of 12 inches and compact it as specified for the adjacent fill.

3.5.2 Frozen Material

Do not place material on surfaces that are muddy, frozen, or contain frost. Finish compaction by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, or other approved equipment well suited to the soil being compacted. Moisten material as necessary to provide the moisture content that will readily facilitate obtaining the specified compaction with the equipment used.

3.6 UTILIZATION OF EXCAVATED MATERIALS

Use satisfactory material removed from excavations, insofar as practicable, in the construction of fills, embankments, subgrades, shoulders, bedding (as backfill), and for similar purposes. Dispose surplus satisfactory excavated material not required for fill and unsatisfactory excavated material as specified in paragraph DISPOSITION OF SURPLUS MATERIAL. Do not dispose excavated material to obstruct the flow of any stream, endanger a partly finished structure, impair the efficiency or appearance of any structure, or be detrimental to the completed work in any way.

3.7 BURIED TAPE AND DETECTION WIRE

3.7.1 Buried Warning and Identification Tape

Provide buried utility lines with utility identification tape. Bury tape **12 inches** below finished grade; under pavements and slabs, bury tape **6 inches** below top of subgrade.

3.8 FILLING, BACKFILLING AND COMPACTION

Place fill and backfill beneath and adjacent to any and all type of structures, in successive horizontal layers of loose material not more than **8 inches** in depth, or in loose layers not more than **5 inches** in depth when using hand-operated compaction equipment. Compact to at least 90 percent of laboratory maximum density for cohesive materials or 95 percent of laboratory maximum density for cohesionless materials, except as otherwise specified. Perform compaction in such a manner as to prevent wedging action or eccentric loading upon or against the structure. Moisture condition fill and backfill material to a moisture content that will readily facilitate obtaining the specified compaction.

Prepare ground surface on which backfill is to be placed and provide compaction requirements for backfill materials in conformance with the applicable portions of paragraphs GROUND SURFACE PREPARATION. Finish compaction by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, vibratory compactors, or other approved equipment.

3.8.1 Trench Backfill

Backfill trenches to the grade shown. Backfill the trench to the top of pipe prior to performing the required pressure tests. Leave the joints and couplings uncovered during the pressure test. Do not backfill the trench until all specified tests are performed.

3.8.1.1 Replacement of Unyielding Material

Replace unyielding material removed from the bottom of the trench with select granular material or initial backfill material.

3.8.1.2 Replacement of Unstable Material

Replace unstable material removed from the bottom of the trench or excavation with select granular material placed in layers not exceeding **6 inches** loose thickness.

3.8.1.3 Bedding and Initial Backfill

Provide bedding of the type and thickness shown.

3.8.1.3.1 Sand

Clean, coarse-grained sand classified as SW or SP by **ASTM D2487** for bedding and backfill.

3.8.1.3.2 Gravel and Crushed Stone

Clean, coarsely graded natural gravel, crushed stone or a combination thereof identified as having a classification of GW in accordance with **ASTM D2487** for bedding as indicated. Do not exceed maximum particle size

of 3 inches.

3.8.1.4 Final Backfill

Fill the remainder of the trench, except for special materials for roadways, railroads and airfields, with satisfactory material. Place backfill material and compact as follows:

3.8.1.4.1 Roadways

Place backfill up to the required elevation as specified. Do not permit water flooding or jetting methods of compaction.

3.8.1.4.2 Sidewalks, Turfed or Seeded Areas and Miscellaneous Areas

Deposit backfill in layers of a maximum of 12 inches loose thickness, and compact it to 85 percent maximum density for cohesive soils and 90 percent maximum density for cohesionless soils. Do not permit compaction by water flooding or jetting. Apply this requirement to all other areas not specifically designated above.

3.8.2 Backfill for Appurtenances

After the manhole, catchbasin, inlet, or similar structure has been constructed place backfill in such a manner that the structure is not be damaged by the shock of falling earth. Deposit the backfill material, compact it as specified for final backfill, and bring up the backfill evenly on all sides of the structure to prevent eccentric loading and excessive stress.

3.9 SPECIAL REQUIREMENTS

Special requirements for both excavation and backfill relating to the specific utilities are as follows:

3.9.1 Gas Distribution

Excavate trenches to a depth that will provide a minimum 18 inches of cover in rock excavation and a minimum 24 inch of cover in other excavation.

3.9.2 Water Lines

Excavate trenches to a depth that provides a minimum cover of 1.5 feet from the existing ground surface, or from the indicated finished grade, whichever is lower, to the top of the pipe.

3.9.3 Electrical Distribution System

Provide a minimum cover of 24 inches from the finished grade to direct burial cable and conduit or duct line, unless otherwise indicated.

3.10 SUBGRADE PREPARATION

3.10.1 Construction

Shape subgrade to line, grade, and cross section, and compact as specified. Include plowing, disking, and any moistening or aerating required to obtain specified compaction for this operation. Remove soft

or otherwise unsatisfactory material and replace with satisfactory excavated material or other approved material as directed. Bring up low areas resulting from removal of unsatisfactory material or excavation of rock to required grade with satisfactory materials, and shape the entire subgrade to line, grade, and cross section and compact as specified. Do not vary the elevation of the finish subgrade more than 0.05 foot from the established grade and cross section.

3.10.2 Compaction

Finish compaction by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, vibratory compactors, or other approved equipment. Except for paved areas, compact each layer of the embankment to at least 95 percent of laboratory maximum density.

3.11 FINISHING

Finish the surface of excavations, embankments, and subgrades to a smooth and compact surface in accordance with the lines, grades, and cross sections or elevations shown. Provide the degree of finish for graded areas within 0.1 foot of the grades and elevations indicated except that the degree of finish for subgrades specified in paragraph SUBGRADE PREPARATION. Finish gutters and ditches in a manner that will result in effective drainage. Finish the surface of areas to be turfed to a smoothness suitable for the application of turfing materials. Repair graded, topsoiled, or backfilled areas prior to acceptance of the work, and re-established grades to the required elevations and slopes.

3.11.1 Subgrade and Embankments

During construction, keep embankments and excavations shaped and drained. Maintain ditches and drains along subgrade to drain effectively at all times. Do not disturb the finished subgrade by traffic or other operation. Protect and maintain the finished subgrade in a satisfactory condition until ballast, subbase, base, or pavement is placed. Do not permit the storage or stockpiling of materials on the finished subgrade. Do not lay subbase, base course, ballast, or pavement until the subgrade has been checked and approved, and in no case place subbase, base, surfacing, pavement, or ballast on a muddy, spongy, or frozen subgrade.

3.11.2 Grading Around Structures

Construct areas within 5 feet outside of each building and structure line true-to-grade, shape to drain, and maintain free of trash and debris until final inspection has been completed and the work has been accepted.

3.12 PLACING TOPSOIL

On areas to receive topsoil, prepare the compacted subgrade soil to a 2 inches depth for bonding of topsoil with subsoil. Spread topsoil evenly to a thickness of 2 inch and grade to the elevations and slopes shown. Do not spread topsoil when frozen or excessively wet or dry. Obtain material required for topsoil in excess of that produced by excavation within the grading limits from areas indicated.

3.13 DISPOSITION OF SURPLUS MATERIAL

Remove surplus material and excavated unsatisfactory material not required or suitable for filling or backfilling, and brush, refuse, stumps, roots,

and timber from Government property and properly disposed of in accordance with all applicable laws and regulations.

-- End of Section --

SECTION 31 31 16.19

TERMITE CONTROL BARRIERS
08/22

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

Title 7 (2019) United States Code, 136 through 136y; Federal Insecticide, Fungicide and Rodenticide Act

1.2 SUBMITTALS

Government approval is required for submittals. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Written Warranty

Chemical Soil Treatment

SD-07 Certificates

Termite Control Company

SD-08 Manufacturer's Instructions

Chemical Soil Treatment

SD-11 Closeout Submittals

Written Warranty

1.3 QUALITY ASSURANCE

Provide termite soil treatment by a termite control company licensed in the state of Alabama.

1.4 DELIVERY, STORAGE, AND HANDLING

1.5 SITE CONDITIONS

1.5.1 Environmental Requirements

In addition to the manufacturer's installation instructions and before placing material, ensure project site is free from standing water.

1.6 WARRANTY

Furnish a 5-year **written warranty** against infestations or reinfestation by subterranean termites of the buildings or building additions constructed under this contract. Written warranty must be jointly signed by an officer of the Contractor and the supplier. Perform annual inspections of the building. If live subterranean termite infestation or subterranean termite damage is discovered during the warranty period, and building conditions have not been altered in the interim, take the following actions:

- a. Correct defective installation and perform other treatment as may be necessary to eliminate subterranean termite infestation.
- b. Repair damage caused by termite infestation.
- c. Reinspect the building approximately 180 calendar days after the repair.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Chemical Soil Treatment

- A. **Toxicant Chemical:** Ref IdEPA Title 7, approved; synthetically color dyed to permit visual identification of treated soil.
- B. **Diluent:** Recommended by toxicant manufacturer.
- C. **Mixes:** Mix toxicant to manufacturer's instructions.

PART 3 EXECUTION

3.1 PREPARATION

Provide finished or temporary site grading to remove standing water from the project site (i.e., excavated areas or adjacent areas). Grading must provide positive drainage towards temporary, new or existing drainage features. Grading must not result in low spots that hold water or direct water towards new or existing facilities.

3.2 INSTALLATION

Treat area under interior slabs on grade with proprietary products registered with EPA for termite protection use. Apply not less than 1 gal. per 10 sf. Apply extra heavy application around pipe openings, etc. Apply along interior perimeters at rate of 2 gallons per 5 lf; where exterior is abutted with pavement, treat exterior side same as interior.

-- End of Section --

SECTION 32 16 19

CONCRETE CURBS, GUTTERS AND SIDEWALKS
05/18

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS
(AASHTO)

AASHTO M 182 (2005; R 2017) Standard Specification for
Burlap Cloth Made from Jute or Kenaf and
Cotton Mats

ASTM INTERNATIONAL (ASTM)

ASTM A615/A615M (2022) Standard Specification for Deformed
and Plain Carbon-Steel Bars for Concrete
Reinforcement

ASTM A1064/A1064M (2022) Standard Specification for
Carbon-Steel Wire and Welded Wire
Reinforcement, Plain and Deformed, for
Concrete

ASTM C31/C31M (2022) Standard Practice for Making and
Curing Concrete Test Specimens in the Field

ASTM C143/C143M (2020) Standard Test Method for Slump of
Hydraulic-Cement Concrete

ASTM C171 (2020) Standard Specification for Sheet
Materials for Curing Concrete

ASTM C172/C172M (2017) Standard Practice for Sampling
Freshly Mixed Concrete

ASTM C173/C173M (2016) Standard Test Method for Air
Content of Freshly Mixed Concrete by the
Volumetric Method

ASTM C231/C231M (2022) Standard Test Method for Air
Content of Freshly Mixed Concrete by the
Pressure Method

ASTM C309 (2019) Standard Specification for Liquid
Membrane-Forming Compounds for Curing
Concrete

ASTM C920 (2018) Standard Specification for
Elastomeric Joint Sealants

ASTM D1751	(2018) Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
ASTM D1752	(2018) Standard Specification for Preformed Sponge Rubber, Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction
ASTM D5893/D5893M	(2016) Standard Specification for Cold Applied, Single Component, Chemically Curing Silicone Joint Sealant for Portland Cement Concrete Pavements

1.2 SUBMITTALS

Government approval is required for submittals. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Concrete

Biodegradable Form Release Agent

SD-06 Test Reports

Field Quality Control

1.3 EQUIPMENT, TOOLS, AND MACHINES

1.3.1 General Requirements

Plant, equipment, machines, and tools used in the work will be subject to approval and must be maintained in a satisfactory working condition at all times. Use equipment capable of producing the required product, meeting grade controls, thickness control and smoothness requirements as specified. Discontinue using equipment that produces unsatisfactory results. Allow the Contracting Officer access at all times to the plant and equipment to ensure proper operation and compliance with specifications.

1.3.2 Slip Form Equipment

Slip form paver or curb forming machines **if used**, will be approved based on trial use on the job and must be self-propelled, automatically controlled, crawler mounted, and capable of spreading, consolidating, and shaping the plastic concrete to the desired cross section in one pass.

1.4 ENVIRONMENTAL REQUIREMENTS

1.4.1 Placing During Cold Weather

Do not place concrete when the air temperature reaches **40 degrees F** and is falling, or is already below that point. Placement may begin when the air temperature reaches **35 degrees F** and is rising, or is already above **40 degrees F**. Make provisions to protect the concrete from freezing during

the specified curing period. If necessary to place concrete when the temperature of the air, aggregates, or water is below 35 degrees F, placement and protection must be approved in writing. Approval will be contingent upon full conformance with the following provisions. Prepare and protect the underlying material so that it is entirely free of frost when the concrete is deposited. Heat mixing water and aggregates as necessary to result in the temperature of the in-place concrete being between 50 and 85 degrees F. Methods and equipment for heating must be approved. Use only aggregates that are free of ice, snow, and frozen lumps before entering the mixer. Provide covering or other means as needed to maintain the concrete at a temperature of at least 50 degrees F for not less than 72 hours after placing, and at a temperature above freezing for the remainder of the curing period.

1.4.2 Placing During Warm Weather

The temperature of the concrete as placed must not exceed 85 degrees F except where an approved retarder is used. Cool the mixing water and aggregates as necessary to maintain a satisfactory placing temperature. The placing temperature must not exceed 95 degrees F at any time.

PART 2 PRODUCTS

2.1 CONCRETE

Provide concrete conforming to the applicable requirements of Section 03 30 00 CAST-IN-PLACE CONCRETE except as otherwise specified. Concrete must have a minimum compressive strength of 3000 psi at 28 days. Size of aggregate must not exceed 1-1/2 inches. Submit copies of certified delivery tickets for all concrete used in the construction.

2.1.1 Air Content

Use concrete mixtures that have an air content by volume of concrete of 5 to 7 percent, based on measurements made immediately after discharge from the mixer.

2.1.2 Slump

Use concrete with a slump of 3 inches plus or minus 1 inch for hand placed concrete or 1 inch plus or minus 1/2 inch for slipformed concrete as determined in accordance with ASTM C143/C143M.

2.1.3 Reinforcement Steel

Use reinforcement bars conforming to ASTM A615/A615M. Use wire mesh reinforcement conforming to ASTM A1064/A1064M.

2.2 CONCRETE CURING MATERIALS

2.2.1 Impervious Sheet Materials

Use impervious sheet materials conforming to ASTM C171, type optional, except that polyethylene film, if used, must be white opaque.

2.2.2 Burlap

Use burlap conforming to AASHTO M 182.

2.2.3 White Pigmented Membrane-Forming Curing Compound

Use white pigmented membrane-forming curing compound conforming to **ASTM C309, Type 1-D, Class A, with fugitive dye added.**

2.3 CONCRETE PROTECTION MATERIALS

Use concrete protection materials consisting of a linseed oil mixture of equal parts, by volume, of linseed oil and either mineral spirits, naphtha, or turpentine. At the option of the Contractor, commercially prepared linseed oil mixtures, formulated specifically for application to concrete to provide protection against the action of deicing chemicals may be used, except that emulsified mixtures are not acceptable.

2.4 JOINT FILLER STRIPS

2.4.1 Contraction Joint Filler for Curb and Gutter

Use hard-pressed fiberboard contraction joint filler for curb and gutter.

2.4.2 Expansion Joint Filler, Premolded

Unless otherwise indicated, use **1/2 inch thick asphalt saturated fiber strips meeting ASTM D1751, cut full depth of concrete after allowance is made for sealant depth.**

Contractor Option to furnish Rubber Expansion Joint material per ASTM D1752, .

Where joint sealer is employed, substitute joint filler of 1/2" thick asphalt saturated fiber strips meeting ASTM D1751, cut full depth of concrete after allowance is made for sealant depth.

2.5 JOINT SEALANTS

Use cold-applied joint sealant conforming to **ASTM C920** or **ASTM D5893/D5893M.**

2.6 FORM WORK

Design and construct form work to ensure that the finished concrete will conform accurately to the indicated dimensions, lines, and elevations, and within the tolerances specified. Use **oil coated** wood or steel forms that are straight and of sufficient strength to resist springing during depositing and consolidating concrete.

2.6.1 Wood Forms

Use forms that are surfaced plank, **2 inches** nominal thickness, straight and free from warp, twist, loose knots, splits or other defects. Use forms with a nominal length of **10 feet**. Radius bends may be formed with **3/4 inch** boards, laminated to the required thickness.

2.6.2 Steel Forms

Use channel-formed sections with a flat top surface and welded braces at each end and at not less than two intermediate points. Use forms with interlocking and self-aligning ends. Provide flexible forms for radius forming, corner forms, form spreaders, and fillers as needed. Use forms with a nominal length of **10 feet** and that have a minimum of 3 welded stake pockets per form. Use stake pins consisting of solid steel rods with

chamfered heads and pointed tips designed for use with steel forms.

2.6.3 Sidewalk Forms

Use sidewalk forms that are of a height equal to the full depth of the finished sidewalk.

2.6.4 Curb and Gutter Forms

Use curb and gutter outside forms that have a height equal to the full depth of the curb or gutter. Use rigid forms for curb returns, except that benders or thin plank forms may be used for curb or curb returns with a radius of 10 feet or more, where grade changes occur in the return, or where the central angle is such that a rigid form with a central angle of 90 degrees cannot be used. Back forms for curb returns may be made of 1-1/2 inch benders, for the full height of the curb, cleated together. In lieu of inside forms for curbs, a curb "mule" may be used for forming and finishing this surface, provided the results are approved.

2.6.5 Biodegradable Form Release Agent

Use form release agent that is colorless and biodegradable and that is composed of at least 87 percent biobased material. Provide product that does not bond with, stain, or adversely affect concrete surfaces and does not impair subsequent treatments of concrete surfaces. Provide form release agent that does not contain diesel fuel, petroleum-based lubricating oils, waxes, or kerosene.

PART 3 EXECUTION

3.1 SUBGRADE PREPARATION

Construct subgrade to the specified grade and cross section prior to concrete placement.

3.1.1 Sidewalk Subgrade

Place and compact the subgrade in accordance with Section 31 00 00 EARTHWORK. Thoroughly wet and compact with mechanical tamper. Cut out spongy or yielding material to a depth of 6 inches and replace with granular material. Test the subgrade for grade and cross section with a template extending the full width of the sidewalk and supported between side forms.

3.1.2 Curb and Gutter Subgrade

Place and compact the subgrade in accordance with Section 31 00 00 EARTHWORK. Test the subgrade for grade and cross section by means of a template extending the full width of the curb and gutter. Use subgrade materials equal in bearing quality to the subgrade under the adjacent pavement.

3.1.3 Maintenance of Subgrade

Maintain subgrade in a smooth, compacted condition in conformity with the required section and established grade until the concrete is placed. The subgrade must be in a moist condition when concrete is placed. Prepare and protect subgrade so that it is free from frost when the concrete is deposited.

3.2 FORM SETTING

Set forms to the indicated alignment, grade and dimensions. Hold forms rigidly in place by a minimum of 3 stakes per form placed at intervals not to exceed 4 feet. Use additional stakes and braces at corners, deep sections, and radius bends, as required. Use clamps, spreaders, and braces where required to ensure rigidity in the forms. Remove forms in a manner that will not injure the concrete. Do not use bars or heavy tools against the concrete when removing the forms. Promptly and satisfactorily repair concrete found to be defective after form removal. Clean forms and coat with form oil or biodegradable form release agent each time before concrete is placed. Wood forms may, instead, be thoroughly wetted with water before concrete is placed, except that with probable freezing temperatures, oiling is mandatory.

3.2.1 Sidewalks

Set forms for 4 inch thick sidewalks with the upper edge true to line and grade with an allowable tolerance of 1/8 inch in any 10 foot long section. After forms are set, grade and alignment must be checked with a 10 foot straightedge. Pitch surface 1 inch in 5 feet to side for surface drainage. Lay out for uniform slope between points indicated, otherwise with top surface 1.5 inches above adjacent lawn grade, or level with top of adjacent curb. Reinforce with 6 x 6 x w1.4/ w1.4 mesh meeting ASTM A1064/A1064M unless noted otherwise. Unless otherwise indicated, construct sidewalks that are located adjacent to curbs with the low side adjacent to the curb. After placing concrete, strike off with side forms and tamp well. Do not remove side forms less than 12 hours after finishing has been completed.

3.2.2 Curbs and Gutters

Remove forms used along the front of the curb not less than 2 hours nor more than 6 hours after the concrete has been placed. Do not remove forms used along the back of curb until the face and top of the curb have been finished, as specified for concrete finishing. Do not remove gutter forms while the concrete is sufficiently plastic to slump in any direction.

3.3 SIDEWALK CONCRETE PLACEMENT AND FINISHING

3.3.1 Formed Sidewalks

Place concrete in the forms in one layer. When consolidated and finished, the sidewalks must be of the thickness indicated. Use a strike-off guided by side forms after concrete has been placed in the forms to bring the surface to proper section to be compacted. Consolidate concrete by tamping and spading or with an approved vibrator. Finish the surface to grade with a strike off.

Where existing walks are to be extended, or where walks are damaged, break back to nearest tooled joint and reconstruct, matching width, finish and scoring.

3.3.2 Concrete Finishing

After straightedging, when most of the water sheen has disappeared, and just before the concrete hardens, finish the surface with a wood or magnesium float or darby to a smooth and uniformly fine granular or sandy

texture free of waves, irregularities, or tool marks. Produce a scored surface by brooming with a fiber-bristle brush in a direction transverse to that of the traffic, followed by edging.

3.3.3 Edge and Joint Finishing

Finish all slab edges, including those at formed joints, with an edger having a radius of $\frac{1}{8}$ inch. Edge transverse joints before brooming. Eliminate the flat surface left by the surface face of the edger with brooming. Clean and solidly fill corners and edges which have crumbled and areas which lack sufficient mortar for proper finishing with a properly proportioned mortar mixture and then finish. Where slope exceeds 5 percent, supplement finish with special shake finish

3.3.4 Surface and Thickness Tolerances

Finished surfaces must not vary more than $\frac{5}{16}$ inch from the testing edge of a 10-foot straightedge. Permissible deficiency in section thickness will be up to $\frac{1}{4}$ inch.

3.3.4.1 Steps:

Carefully form to profile shown with treads pitched $\frac{1}{4}$ inch for drainage, rise and run uniform in any single flight. Exposed edges slightly rounded. Finish treads to match walks and rub finish vertical surfaces as specified under Section 03 30 00.

3.4 CURB AND GUTTER CONCRETE PLACEMENT AND FINISHING

3.4.1 Formed Curb and Gutter

Produce curbs at concrete pavement to profile indicated, with joint pattern of pavement extended through curb. Carefully tool along top edges, and slightly round form where curb face meets pavement.

Construct to indicated profile in sections with uniform length of ten feet, varied as required to work out, but with no length less than six feet. Separate sections with $\frac{1}{8}$ inch thick steel templates conforming to and 2 inches deeper than curb profile, removed as soon after pouring as practical.

Valley gutters shall be 3 feet wide and of same thickness and construction as curb gutter. Terminate at ends with curb return.

Place concrete to the required section in a single lift. Consolidate concrete using approved mechanical vibrators. Curve shaped gutters must be finished with a standard curb "mule".

3.4.2 Curb and Gutter Finishing

Approved slipformed curb and gutter machines may be used in lieu of hand placement.

3.4.3 Concrete Finishing

Float and finish exposed surfaces with a smooth wood float until true to grade and section and uniform in texture. Brush floated surfaces with a fine-hair brush using longitudinal strokes. Round the edges of the gutter and top of the curb with an edging tool to a radius of $\frac{1}{2}$ inch.

Immediately after removing the front curb form, rub the face of the curb with a wood or concrete rubbing block and water until blemishes, form marks, and tool marks have been removed. Brush the front curb surface, while still wet, in the same manner as the gutter and curb top. Finish the top surface of gutter and entrance to grade with a wood float.

3.4.4 Joint Finishing

Finish curb edges at formed joints as indicated. Cut to match curb profile and extending to within 1/4 inch of top surface. Install wherever curb ends contact a restricting mass, at all curb returns, at tangent points, and on 50-foot intervals between.

3.4.5 Surface and Thickness Tolerances

Finished surfaces must not vary more than 1/4 inch from the testing edge of a 10-foot straightedge. Permissible deficiency in section thickness will be up to 1/4 inch.

3.5 SIDEWALK JOINTS

Provide cross scoring uniformly spaced approximately 4 feet apart unless shown otherwise, with full depth contraction joints not over 12 feet apart. Work out pattern to align with joints in adjacent work or other architectural elements. Install (in cross scoring pattern) expansion joints not over 30 feet apart and where walk contacts building, curb, crosswalk, steps, or other restricting mass.

3.5.1 Sidewalk Contraction Joints

Form contraction joints in the fresh concrete by cutting a groove in the top portion of the slab to a depth of at least one-fourth of the sidewalk slab thickness. Unless otherwise approved or indicated, either use a jointer to cut the groove or saw a groove in the hardened concrete with a power-driven saw. Construct sawed joints by sawing a groove in the concrete with a 1/8 inch blade. Provide an ample supply of saw blades on the jobsite before concrete placement is started. Provide at least one standby sawing unit in good working order at the jobsite at all times during the sawing operations.

3.5.2 Sidewalk Expansion Joints

Form expansion joints using 1/2 inch joint filler strips. Joint filler in expansion joints surrounding structures and features within the sidewalk may consist of preformed filler material conforming to ASTM D1752 or building paper. Hold joint filler in place with steel pins or other devices to prevent warping of the filler during floating and finishing. Immediately after finishing operations are completed, round joint edges using an edging tool having a radius of 1/8 inch. Remove any concrete over the joint filler. At the end of the curing period, clean the top of expansion joints and fill with cold-applied joint sealant. Use joint sealant that is gray or stone in color. Thoroughly clean the joint opening before the sealing material is placed. Do not spill sealing material on exposed surfaces of the concrete. Apply joint sealing material only when the concrete at the joint is surface dry and atmospheric and concrete temperatures are above 50 degrees F. Immediately remove any excess material on exposed surfaces of the concrete and clean the concrete surfaces.

3.5.3 Reinforcement Steel Placement

Accurately and securely fasten reinforcement steel in place with suitable supports and ties before the concrete is placed.

3.6 CURB AND GUTTER JOINTS

Construct curb and gutter joints at right angles to the line of curb and gutter.

3.6.1 Contraction Joints

Construct contraction joints directly opposite contraction joints in abutting portland cement concrete pavements and spaced so that monolithic sections between curb returns will not be less than 5 feet nor greater than 15 feet in length.

- a. Construct contraction joints (except for slip forming) by means of 1/8 inch thick separators and of a section conforming to the cross section of the curb and gutter. Remove separators as soon as practicable after concrete has set sufficiently to preserve the width and shape of the joint and prior to finishing.
- b. When slip forming is used, cut the contraction joints in the top portion of the gutter/curb hardened concrete in a continuous cut across the curb and gutter, using a power-driven saw. Cut the contraction joint to a depth of at least one-fourth of the gutter/curb depth using a 1/8 inch saw blade.

3.6.2 Expansion Joints

Form expansion joints by means of preformed expansion joint filler material cut and shaped to the cross section of curb and gutter. Construct expansion joints in curb and gutter directly opposite expansion joints of abutting portland cement concrete pavement using the same type and thickness of joints as joints in the pavement. Where curb and gutter do not abut portland cement concrete pavement, provide expansion joints at least 1/2 inch in width at intervals not less than 30 feet nor greater than 120 feet. Seal expansion joints immediately following curing of the concrete or as soon thereafter as weather conditions permit. Seal expansion joints and the top 1 inch depth of curb and gutter contraction-joints with joint sealant. Thoroughly clean the joint opening before the sealing material is placed. Do not spill sealing material on exposed surfaces of the concrete. Concrete at the joint must be surface dry and atmospheric and concrete temperatures must be above 50 degrees F at the time of application of joint sealing material. Immediately remove excess material on exposed surfaces of the concrete and clean concrete surfaces.

3.7 CURING AND PROTECTION

3.7.1 General Requirements

Protect concrete against loss of moisture and rapid temperature changes for at least 5 days from the beginning of the curing operation. Protect unhardened concrete from rain and flowing water. All equipment needed for adequate curing and protection of the concrete must be on hand and ready for use before actual concrete placement begins. Protect concrete as necessary to prevent cracking of the pavement due to temperature changes

during the curing period.

3.7.1.1 Mat Method

Cover the entire exposed surface with two or more layers of burlap. Overlap mats at least **6 inches**. Thoroughly wet the mat with water prior to placing on concrete surface and keep the mat continuously in a saturated condition and in intimate contact with concrete for not less than **48 hours**.

3.7.1.2 Impervious Sheeting Method

Wet the entire exposed surface with a fine spray of water and then cover with impervious sheeting material. Lay sheets directly on the concrete surface with the light-colored side up and overlapped **12 inches** when a continuous sheet is not used. Use sheeting that is not less than **18-inches** wider than the concrete surface to be cured. Secure sheeting using heavy wood planks or a bank of moist earth placed along edges and laps in the sheets. Satisfactorily repair or replace sheets that are torn or otherwise damaged during curing. Sheeting must remain on the concrete surface to be cured for not less than 7 days.

3.7.1.3 Membrane Curing Method

Apply a uniform coating of white-pigmented membrane-curing compound to the entire exposed surface of the concrete as soon after finishing as the free water has disappeared from the finished surface. Coat formed surfaces immediately after the forms are removed and in no case longer than 1 hour after the removal of forms. Do not allow concrete surface to dry before application of the membrane. If drying has occurred, moisten the surface of the concrete with a fine spray of water and apply the curing compound as soon as the free water disappears. Apply curing compound in two coats by hand-operated pressure sprayers at a coverage of approximately **200 square feet/gallon** for the total of both coats. Apply the second coat in a direction approximately at right angles to the direction of application of the first coat. The compound must form a uniform, continuous, coherent film that will not check, crack, or peel and must be free from pinholes or other imperfections. If pinholes, abrasion, or other discontinuities exist, apply an additional coat to the affected areas within 30 minutes. Respray concrete surfaces that are subjected to heavy rainfall within 3 hours after the curing compound has been applied by the method and at the coverage specified above. Respray areas where the curing compound is damaged by subsequent construction operations within the curing period. Take precautions necessary to ensure that the concrete is properly cured at sawed joints, and that no curing compound enters the joints. Tightly seal the top of the joint opening and the joint groove at exposed edges before the concrete in the region of the joint is resprayed with curing compound. Use a method used for sealing the joint groove that prevents loss of moisture from the joint during the entire specified curing period. Provide approved standby facilities for curing concrete pavement at a location accessible to the jobsite for use in the event of mechanical failure of the spraying equipment or other conditions that might prevent correct application of the membrane-curing compound at the proper time. Adequately protect concrete surfaces to which membrane-curing compounds have been applied during the entire curing period from pedestrian and vehicular traffic, except as required for joint-sawing operations and surface tests, and from other possible damage to the continuity of the membrane.

3.7.2 Backfilling

After curing, remove debris and backfill, grade, and compact the area adjoining the concrete to conform to the surrounding area in accordance with lines and grades indicated.

3.7.3 Protection

Protect completed concrete from damage until accepted. Repair damaged concrete and clean concrete discolored during construction. Remove and reconstruct concrete that is damaged for the entire length between regularly scheduled joints. Refinishing the damaged portion will not be acceptable. Dispose of removed material as directed.

3.8 FIELD QUALITY CONTROL

Submit copies of all test reports within 24 hours of completion of the test.

3.8.1 General Requirements

Perform the inspection and tests described and meet the specified requirements for inspection details and frequency of testing. Based upon the results of these inspections and tests, take the action and submit reports as required below, and additional tests to ensure that the requirements of these specifications are met.

3.8.2 Concrete Testing

3.8.2.1 Strength Testing

Take concrete samples in accordance with [ASTM C172/C172M](#) not less than once a day nor less than once for every [250 cubic yards](#) of concrete placed. Mold cylinders in accordance with [ASTM C31/C31M](#) for strength testing by an approved laboratory. Each strength test result must be the average of 2 test cylinders from the same concrete sample tested at 28 days, unless otherwise specified or approved. Concrete specified on the basis of compressive strength will be considered satisfactory if the averages of all sets of three consecutive strength test results equal or exceed the specified strength, and no individual strength test result falls below the specified strength by more than [500 psi](#).

3.8.2.2 Air Content

Determine air content in accordance with [ASTM C173/C173M](#) or [ASTM C231/C231M](#). Use [ASTM C231/C231M](#) with concretes and mortars made with relatively dense natural aggregates. Make two tests for air content on randomly selected batches of each class of concrete placed during each shift. Make additional tests when excessive variation in concrete workability is reported by the placing foreman or the Government inspector. Notify the placing foreman if results are out of tolerance. The placing foreman must take appropriate action to have the air content corrected at the plant. Additional tests for air content will be performed on each truckload of material until such time as the air content is within the tolerance specified.

3.8.2.3 Slump Test

Perform two slump tests on randomly selected batches of each class of

concrete for every 250 cubic yards, or fraction thereof, of concrete placed during each shift. Perform additional tests when excessive variation in the workability of the concrete is noted or when excessive crumbling or slumping is noted along the edges of slip-formed concrete.

3.8.3 Thickness Evaluation

Determine the anticipated thickness of the concrete prior to placement by passing a template through the formed section or by measuring the depth of opening of the extrusion template of the curb forming machine. If a slip form paver is used for sidewalk placement, construct the subgrade true to grade prior to concrete placement. The thickness will be determined by measuring each edge of the completed slab.

3.8.4 Surface Evaluation

Provide finished surfaces for each category of the completed work that are uniform in color and free of blemishes and form or tool marks.

3.9 SURFACE DEFICIENCIES AND CORRECTIONS

3.9.1 Thickness Deficiency

When measurements indicate that the completed concrete section is deficient in thickness by more than 1/4 inch the deficient section will be removed, between regularly scheduled joints, and replaced.

3.9.2 High Areas

In areas not meeting surface smoothness and plan grade requirements, reduce high areas either by rubbing the freshly finished concrete with carborundum brick and water when the concrete is less than 36 hours old or by grinding the hardened concrete with an approved surface grinding machine after the concrete is 36 hours old or more. The area corrected by grinding the surface of the hardened concrete must not exceed 5 percent of the area of any integral slab, and the depth of grinding must not exceed 1/4 inch. Remove and replace pavement areas requiring grade or surface smoothness corrections in excess of the limits specified.

3.9.3 Appearance

Exposed surfaces of the finished work will be inspected by the Contracting Officer and deficiencies in appearance will be identified. Remove and replace areas which exhibit excessive cracking, discoloration, form marks, or tool marks or which are otherwise inconsistent with the overall appearances of the work.

-- End of Section --

SECTION 32 31 13

CHAIN LINK FENCES AND GATES
11/21

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM A392	(2011; R 2022a) Standard Specification for Zinc-Coated Steel Chain-Link Fence Fabric
ASTM A780/A780M	(2020) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM C94/C94M	(2022a) Standard Specification for Ready-Mixed Concrete
ASTM F567	(2014a; R 2019) Standard Practice for Installation of Chain Link Fence
ASTM F626	(2014; R 2019) Standard Specification for Fence Fittings
ASTM F883	(2013; R 2022) Standard Performance Specification for Padlocks

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FS RR-F-191/1	(Rev F) Fencing, Wire and Post, Metal (Chain-Link Fence Fabric)
FS RR-F-191/2	(Rev E) Fencing, Wire and Post, Metal (Chain-Link Fence Gates)
FS RR-F-191/3	(Rev E; Am 1) Fencing, Wire and Post, Metal (Chain-Link Fence Posts, Top Rails and Braces)
FS RR-F-191/4	(Rev F) Fencing, Wire and Post, Metal (Chain-Link Fence Accessories)

1.2 SUBMITTALS

Government approval is required for submittals . Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Fence Assembly

Location of Gate, Corner, End, and Pull Posts

Gate Assembly

Gate Hardware and Accessories

Erection/Installation Drawings

SD-03 Product Data

Fence Assembly

Gate Assembly

Gate Hardware and Accessories

Zinc Coating

Fabric

Stretcher Bars

Concrete

Line Posts

Braces

Top Rail

Wire Ties

Sleeves

Gate Posts

Padlocks

SD-07 Certificates

Certificates of Compliance

Recycled Material Content

SD-08 Manufacturer's Instructions

Fence Assembly

Gate Assembly

Hardware Assembly

Accessories

1.3 QUALITY CONTROL

1.3.1 Certificates of Compliance

Submit [certificates of compliance](#) in accordance with the applicable

reference standards and descriptions of this section for the following:

- a. Zinc coating
- b. Fabric
- c. Stretcher bars
- d. Gate hardware and accessories
- e. Concrete

1.4 DELIVERY, STORAGE, AND HANDLING

Deliver materials to site in an undamaged condition. Store materials off the ground to provide protection against oxidation caused by ground contact.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

Submit reports of listing chain-link fencing and accessories regarding weight in ounces for zinc coating.

Submit manufacturer's catalog data for complete fence assembly, gate assembly, hardware assembly and accessories.

2.2 FENCES

2.2.1 Fabric

FS RR-F-191/1; Type I, zinc-coated steel, 9 gauge conforming to ASTM A392, with 1.80 ounces per square foot of coated surface . Provide selvage knuckled at one selvage and twisted and barbed at the other . Height of fabric, as indicated.

Provide fabric consisting of wires woven into a 2 inch diamond mesh. Provide one-piece fabric widths for fence heights up to 8 feet.

2.2.1.1 Top and Bottom Selvages

Provide knuckled selvages at top and bottom for fabric with 2 inch mesh and up to 60 inches high, and if over 60 inches high, provide twisted and barbed top selvage and knuckled bottom selvage.

Knuckle top and bottom selvages for 1-3/4 inch and 1 inch mesh fabric.

2.2.2 Posts

2.2.2.1 Metal

2.2.2.1.1 Line Posts

Provide line posts complying with FS RR-F-191/3. Provide Class 1, steel pipe, Grade A Regular Strength or , in 1.9 inch od at 2.72 plf..

2.2.2.1.2 End, Corner and Pull Posts

Provide terminal and corner posts 2.87 inch od at 5.79 plf; Gate posts 4 inch od. Intermediate posts . Provide Class 1, steel pipe, Grade A Regular Strength.

2.2.2.2 Post Tops

Provide steel, wrought iron, or malleable iron tops and designed as a weathertight closure cap. Post top to have finish and coating matching rails and posts. Steel type to be pressed steel galvanized after fabrication having a minimum zinc coating of 1.20 ounces per square foot.

2.2.3 Braces and Rails

Class 1, steel pipe, Grade A Regular Strength, in minimum sizes listed in FS RR-F-191/3 for each class and grade.

2.2.3.1 Top Rail

Provide top rail conforming to minimum sizes specified in FS RR-F-191/3 for each class and grade unless members are to be oversized. Provide expansion couplings 6 inches long at each joint in top rails.

2.2.3.2 Post-Brace Assembly

Provide bracing conforming to minimum sizes specified in FS RR-F-191/3 for each class and grade, and 3/8 inch adjustable truss rods and turnbuckles.

2.2.4 Wire Ties

Provide 9-gauge wire for tying fabric to line posts, spaced 15 inches on center. For tying fabric to rails and braces, space wire ties 24 inches on center. Manufacturer's standard procedure will be accepted if of equal strength and durability.

FS RR-F-191/4. Provide wire ties constructed of the same material and coating as the fencing fabric.

2.2.5 Sleeves

Provide sleeves for setting into concrete construction of the same material as post sections, sized 1 inch greater than the diameter or dimension of the post. Weld flat plates to each sleeve base to provide anchorage and prevent intrusion of concrete.

2.2.6 Stretcher Bars

Provide bars that have one-piece lengths equal to the full height of the fabric with a minimum cross section of 3/16 by 3/4 inch, in accordance with ASTM F626.

2.2.7 Stretcher Bar Bands

Provide bar bands for securing stretcher bars to posts that are steel, wrought iron, or malleable iron spaced not over 15 inches on center. Bands may also be used in conjunction with special fittings for securing rails to posts. Provide bands with projecting edges chamfered or eased.

2.2.8 Miscellaneous Hardware

Provide miscellaneous hot-dip galvanized hardware as required.

2.3 GATES

FS RR-F-191/2; Type I, single swing. Shape and size of gate frame, as indicated. Framing and bracing members, round of steel alloy. Steel member finish, zinc-coated. Provide gate frames and braces of minimum sizes listed in FS RR-F-191/3 for each Class and Grade, except that steel pipe frames are a minimum of 1.90 inches o.d., 0.120 inches minimum wall thickness and aluminum pipe frames and intermediate braces are 1.869 inches o.d. minimum, 0.940 lb/ft of length.

2.3.1 Gate Posts

Provide gate posts for supporting each gate leaf in minimum sizes listed in FS RR-F-191/3 for each material class and grade. Gate post material class, grade and finish to match other fence posts.

2.3.2 Gate Fabric

Gate fabric, is as specified for fencing fabric. Attach gate fabric to gate frame in accordance with manufacturer's standards, except that welding is not permitted.

2.3.3 Gate Frame

Provide gate frame assembly that is welded or assembled with special malleable or pressed-steel fittings and rivets to provide rigid connections. Install fabric with stretcher bars at vertical edges; stretcher bars may also be used at top and bottom edges. Attach stretcher bars and fabric to gate frames on all sides at intervals not exceeding 15 inches. Attach hardware with rivets or by other means which provides equal security against breakage or removal.

2.3.4 Gate Bracing

Provide diagonal cross-bracing, consisting of 3/8 inch diameter adjustable-length truss rods on welded gate frames, where necessary to obtain frame rigidity without sag or twist. Provide nonwelded gate frames with diagonal bracing.

2.3.5 Padlocks

Provide padlocks conforming to ASTM F883, with chain.

2.3.6 Gate Hardware and Accessories

Provide gate hardware and accessories that conforms to ASTM A392 and ASTM F626, and as specified. Coating for steel latches, stops, hinges, keepers, and accessories, is galvanized

- a. Provide forged steel hinges to suit gate size, non-lift-off type, offset to permit 180-degree opening. Provide hinge with stainless steel pin.
- b. Provide latch that permits accessibility and operation from either side of the gate regardless of the latching arrangement, and with a

padlock eye provided as an integral part of the latch. Provide a heavy duty padlock type fork gate latches.

2.4 MATERIALS

2.4.1 Zinc Coating

Provide zinc-coated ferrous metal components and accessories that are factory coated after fabrication, except as otherwise specified.

For galvanizing field repairs, provide material that is cold-applied zinc-rich coating conforming to ASTM A780/A780M.

2.4.2 Concrete

Provide concrete conforming to ASTM C94/C94M, and obtaining a minimum 28-day compressive strength of 3,000 psi.

2.4.3 Grout

Provide grout of proportions one part portland cement to three parts clean, well-graded sand and a minimum amount of water to produce a workable mix.

PART 3 EXECUTION

Submit manufacturer's erection/installation drawings and instructions that detail proper assembly and materials in the design for fence, gate, hardware and accessories.

Provide complete installation conforming to ASTM F567.

3.1 PREPARATION

Ensure final grading and established elevations are complete prior to commencing fence installation.

3.2 INSTALLATION

3.2.1 Fence Installation

Install fence on prepared surfaces to line and grade indicated. Secure fastening and hinge hardware in place to fence framework by peening or welding. Allow for proper operation of components. Coat peened or welded areas with a repair coating matching original coating. Install fence in accordance with fence manufacturer's written installation instructions except as modified herein.

3.2.1.1 Post Spacing

Provide line posts spaced equidistantly apart, not exceeding 10 feet on center. Provide gate posts spaced as necessary for size of gate openings. Do not exceed 500 feet on straight runs between braced posts. Provide corner or pull posts, with bracing in both directions, for changes in direction of 15 degrees or more, or for abrupt changes in grade. Submit drawings showing location of gate, corner, end, and pull posts.

3.2.2 Excavation

Provide excavations for post footings which are drilled holes in virgin or compacted soil.

Line post holes shall be 36 inches deep with posts set 32 inches into concrete. Terminal and corner post holes shall be 40 inches deep with posts set 36 inches into concrete. Footing shall be not less than 12 inches diameter.

Space footings for line posts 10 feet on center maximum and at closer intervals when indicated, with bottoms of the holes approximately 3 inches below the bottoms of the posts. Set posts deeper, as required, in soft and problem soils and for heavy, lateral loads. Uniformly spread soil from excavations adjacent to the fence line or on areas of Government property, as directed.

3.2.3 Setting Posts

Remove loose and foreign materials from holes and moisten the soil prior to placing concrete. Provide tops of footings that are trowel finished and sloped or domed to shed water away from posts. Set hold-open devices, sleeves, and other accessories in concrete.

Keep exposed concrete moist for at least 7 calendar days after placement or cured with a membrane curing material, as approved. Grout all posts set into sleeved holes in concrete with an approved grouting material. Maintain vertical alignment of posts in concrete construction until concrete has set.

3.2.3.1 Bracing

Brace gate, corner, end, and pull posts to nearest post with a horizontal brace used as a compression member, placed at least 12 inches below top of fence, and a diagonal tension rod.

3.2.3.2 Tolerances

Provide posts that are straight and plumb within a vertical tolerance of 1/4 inch after the fabric has been stretched. Provide fencing and gates that are true to line with no more than 1/2 inch deviation from the established centerline between line posts. Repair defects as directed.

3.2.4 Concrete Strength

Provide concrete that has attained at least 75 percent of its minimum 28-day compressive strength, but in no case sooner than 7 calendar days after placement, before rails, tension wire, or fabric are installed. Do not stretch fabric and wires or hang gates until the concrete has attained its full design strength.

3.2.5 Top Rails

Provide top rails that run continuously through post caps or extension arms, bending to radius for curved runs. Provide expansion couplings as recommended by the fencing manufacturer.

3.2.6 Brace Assembly

Provide bracing assemblies at end and gate posts and at both sides of corner and pull posts, with the horizontal brace located at midheight of the fabric.

Install brace assemblies so posts are plumb when the diagonal rod is under proper tension. Provide two complete brace assemblies at corner and pull posts where required for stiffness and as indicated.

3.2.7 Fabric Installation

Provide fabric in single lengths between stretch bars with bottom barbs placed approximately 1-1/2 inches above the ground line. Pull fabric taut and tied to posts, and rails with wire ties and bands.

Top of fence shall be in a straight line, parallel with finish grade. Posts shall be plumb. Bottom edge of fabric shall be buried 3 to 5 inches into the ground.

Install fabric on the security side of fence, unless otherwise directed. Ensure fabric remains under tension after the pulling force is released.

3.2.8 Stretcher Bar Installation

Thread stretcher bars through or clamped to fabric 4 inches on center and secured to posts with metal bands spaced 15 inches on center.

3.2.9 Gate Installation

Install gates plumb, level, and secure, with full opening without interference. Install ground set items in concrete for anchorage as recommended by the fence manufacturer. Adjust hardware for smooth operation and lubricated where necessary.

3.2.10 Tie Wires

Provide tie wires that are U-shaped to the pipe diameters to which attached. Twist ends of tie wires not less than two full turns and bent so as not to present a hazard.

3.2.11 Fasteners

Install nuts for tension bands and hardware on the side of the fence opposite the fabric side. Peen ends of bolts to prevent removal of nuts.

3.2.12 Zinc-Coating Repair

Clean and repair galvanized surfaces damaged by welding or abrasion, and cut ends of fabric, or other cut sections with specified galvanizing repair material applied in strict conformance with the manufacturer's printed instructions.

3.2.13 Accessories Installation

3.2.13.1 Post Caps

Design post caps to accommodate top rail. Install post caps as recommended by the manufacturer.

3.2.13.2 Padlocks

Provide padlocks for gate openings and provide chains that are securely attached to gate or gate posts. Provide padlocks keyed alike, and provide two keys for each padlock.

3.3 CLOSEOUT ACTIVITIES

Remove waste fencing materials and other debris from the work site.

Submit manufacturer's data indicating percentage of [recycled material content](#) in protective fence materials, including chain link fence, fabric, and gates to verify affirmative procurement compliance.

-- End of Section --

SECTION 32 92 23

SODDING

04/06, CHG 1: 08/21

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D4972 (2018) Standard Test Methods for pH of Soils

TURFGRASS PRODUCERS INTERNATIONAL (TPI)

TPI GSS (1995) Guideline Specifications to Turfgrass Sodding

1.2 DEFINITIONS

1.2.1 Stand of Turf

100 percent ground cover of the established species.

1.3 SUBMITTALS

Government approval is required for submittals . Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Fertilizer

Include physical characteristics, and recommendations.

SD-07 Certificates

Sod farm certification for sods. Indicate type of sod in accordance with TPI GSS.

1.4 DELIVERY, STORAGE, AND HANDLING

1.4.1 Delivery

1.4.1.1 Sod Protection

Protect from drying out and from contamination during delivery, on-site storage, and handling.

1.4.1.2 Fertilizer and Lime Delivery

Deliver to the site in original, unopened containers bearing manufacturer's chemical analysis, name, trade name, trademark, and

indication of conformance to state and federal laws. Instead of containers, fertilizer and lime may be furnished in bulk with certificate indicating the above information.

1.4.2 Storage

1.4.2.1 Sod Storage

Lightly sprinkle with water, cover with moist burlap, straw, or other approved covering; and protect from exposure to wind and direct sunlight until planted. Provide covering that will allow air to circulate so that internal heat will not develop. Do not store sod longer than 24 hours. Do not store directly on concrete or bituminous surfaces.

1.4.2.2 Topsoil

Prior to stockpiling topsoil, treat growing vegetation with application of appropriate specified non-selective herbicide. Clear and grub existing vegetation three to four weeks prior to stockpiling topsoil.

1.4.2.3 Handling

Do not drop or dump materials from vehicles.

1.5 TIME RESTRICTIONS AND PLANTING CONDITIONS

1.5.1 Restrictions

Do not plant when the ground is frozen, snow covered, muddy, or when air temperature exceeds 90 degrees Fahrenheit.

1.6 TIME LIMITATIONS

1.6.1 Sod

Place sod a maximum of thirty six hours after initial harvesting, in accordance with TPI GSS as modified herein.

PART 2 PRODUCTS

2.1 SODS

2.1.1 Classification

Nursery grown, certified as classified in the TPI GSS. Machine cut sod shall be carefully stripped from a cultivated field, cut into strips or squares averaging 3 inches in depth, arrive at project in freshly dug condition, and be planted not later than 24 hours after lifting. Each individual sod piece shall be strong enough to support its own weight when lifted by the ends. Handle carefully to keep native soil on roots; if stacked during storage place root to root or grass to grass. Broken pads, irregularly shaped pieces, and torn or uneven ends will be rejected. Wood pegs and wire staples for anchorage shall be as recommended by sod supplier.

2.1.2 Purity

Sod species shall be genetically pure, free of weeds, pests, and disease.

2.1.3 Planting Dates

In any season, planting shall be done only during periods when soil moisture conditions are favorable, and only if in the Architect's judgement, the general construction and sub-grade work is sufficiently advanced.

2.1.4 Composition

2.1.4.1 Proportion

Proportion grass species as follows.

Botanical Name	Common Name	Percent
Cynoden Dactylon	Bermuda Grass	100

2.1.4.2 Sod Farm Overseeding

At the sod farm provide sod with overseeding of Italian Rye Grass seed.

2.2 TOPSOIL

2.2.1 On-Site Topsoil

Surface soil stripped and stockpiled on site and modified as necessary to meet the requirements specified for topsoil in paragraph entitled "Composition." When available topsoil shall be existing surface soil stripped and stockpiled on-site.

2.2.2 Off-Site Topsoil

Conform to requirements specified in paragraph entitled "Composition." Additional topsoil shall be furnished by the Contractor.

2.2.3 Composition

Topsoil shall be fertile, natural soil of suitable loamy character obtained from a well-drained site. It shall contain a normal amount of decomposed matter, but be free of heavy clay, stones, roots and plants, and have a pH of 6 to 6.5. Furnish a soil test report prior to its application. The pH shall be tested in accordance with ASTM D4972. Topsoil shall be free of sticks, stones, roots, and other debris and objectionable materials.

2.3 SOIL CONDITIONERS

Add conditioners to topsoil as required to bring into compliance with "composition" standard for topsoil as specified herein.

2.3.1 Lime

ground limestone containing not less than 85% of total carbonates and

shall be ground to such a fineness that 50% will pass through a 100-mesh sieve. Coarser material will be acceptable, provided the specified rates of application are increased proportionately on the basis of quantities passing the 100-mesh sieve.

2.3.2 Sand

Clean and free of materials harmful to plants.

2.4 FERTILIZER

2.4.1 Granular Fertilizer

Organic, granular controlled release fertilizer containing the following minimum percentages, by weight, of plant food nutrients:

8 percent available nitrogen

8 percent available phosphorus

8 percent available potash

2.5 WATER

Source of water shall be approved by Contracting Officer and of suitable quality for irrigation containing no element toxic to plant life.

PART 3 EXECUTION

3.1 PREPARATION

3.1.1 Extent Of Work

Provide soil preparation (including soil conditioners), fertilizing, and sodding of all newly graded finished earth surfaces, unless indicated otherwise, and at all areas inside or outside the limits of construction that are disturbed by the Contractor's operations.

3.1.2 Grading

Remove all debris, gravel and other unsuitable materials. Turn under all present sod and disc or otherwise loosen soil to depth of at least 6 inches below finished surface. Check for and correct all inaccurate sub-grading, making allowance for any topsoil yet to be placed. Establish finish gradients indicated on site plan, dressing out with walks, curbs, etc., and facilitating surface drainage. Round off changes in slope at bottom and top of banks, etc., for convenient maintenance. Do not proceed with final preparation until immediately preceding the planting season.

3.1.3 Soil Preparation

Provide 2 inches of on-site topsoil to meet indicated finish grade. After areas have been brought to indicated finish grade, incorporate fertilizer into soil a minimum depth of 4 inches by disking, harrowing, tilling or other method approved by the Contracting Officer. Remove debris and stones larger than 3/4 inch in any dimension remaining on the surface after finish grading. Correct irregularities in finish surfaces to eliminate depressions. Protect finished topsoil areas from damage by vehicular or pedestrian traffic.

3.1.3.1 Soil Conditioner Application Rates

Apply soil conditioners at rates as determined by laboratory soil analysis of the soils at the job site. For bidding purposes only apply at rates for the following:

Lime 30 pounds per 1000 square feet.

Sand: Utilize as a supplement to topsoil where difficult to spread and work well. Rake and dress to finish grades shown on plans. Also, use sand to fill voids between blocks of sod. Sand shall be fine bed lawn sand free of foreign material, suitable for this use.

3.1.3.2 Fertilizer Application Rates

Apply fertilizer at rates as determined by laboratory soil analysis of the soils at the job site. For bidding purposes only apply at rates for the following:

Apply at least two but not more than eight days prior to sodding, apply complete inorganic fertilizer (8% nitrogen, 8% phosphorous, and 8% potash) at rate of 35 lbs. per 1000 sq. ft. of surface. Material must be of uniform composition, dry and free flowing, delivered to site in original containers with manufacturer's analysis attached. Rake lightly into soil and water in.

3.2 SODDING

3.2.1 Finished Grade and Topsoil

Prior to the commencement of the sodding operation, the Contractor shall verify that finished grades are as indicated on drawings; the placing of topsoil, smooth grading, and compaction requirements have been completed.

The prepared surface shall be a maximum 1 inch below the adjoining grade of any surfaced area. New surfaces shall be blended to existing areas. The prepared surface shall be completed with a light raking to remove from the surface debris and stones over a minimum 5/8 inch in any dimension.

3.2.2 Placing

Place sod a maximum of 24 hours after initial harvesting, in accordance with TPI GSS as modified herein. Lay out solid in strips without wide joints. Place strip or spot sod so that surface of compacted sod is slightly below surrounding surface soil.

3.2.3 Sodding Slopes and Ditches

For slopes 2:1 and greater, lay sod with long edge perpendicular to the contour. For V-ditches and flat bottomed ditches, lay sod with long edge perpendicular to flow of water. Anchor each piece of sod with wood pegs or wire staples maximum 2 feet on center. On slope areas, start sodding at bottom of the slope.

3.2.4 Finishing

After completing sodding, blend edges of sodded area smoothly into surrounding area. Air pockets shall be eliminated and a true and even

surface shall be provided. Frayed edges shall be trimmed and holes and missing corners shall be patched with sod.

3.2.5 Rolling

Immediately after sodding, firm entire area except for slopes in excess of 3 to 1 with a roller not exceeding 90 pounds for each foot of roller width.

3.2.6 Watering

Start watering areas sodded as required by daily temperature and wind conditions. Apply water at a rate sufficient to ensure thorough wetting of soil to minimum depth of 6 inches. Run-off, puddling, and wilting shall be prevented. Unless otherwise directed, watering trucks shall not be driven over turf areas. Watering of other adjacent areas or plant material shall be prevented.

3.3 PROTECTION OF TURF AREAS

Immediately after turfing, protect area against traffic and other use.

3.4 Maintenance:

Maintain planted areas and perform all routine watering, weeding, mowing and trimming until lawns are uniformly established, healthy and growing; and until acceptance of overall project, whichever is later. Replant all areas that do not show a good catch and replace any area showing excessive foreign growth within one growing season.

Fill gullies and washed places and maintain finished grades until surface is secured with lawn growth. Replant areas affected. Protect surfaces against trespassing or other damage.

Where work is temporarily halted, stake planks or other effective terminator which will hold sod until resumption of work.

3.5 RESTORATION

Promptly remove any soil or similar material which has been brought onto paved areas; keep area clean at all times. Upon completion of work, remove from site all excess soil, stones, and debris.

Restore to original condition existing turf areas which have been damaged during turf installation operations. Keep clean at all times at least one paved pedestrian access route and one paved vehicular access route to each building. Clean other paving when work in adjacent areas is complete.

-- End of Section --