

TECHNICAL SPECIAL PROVISION

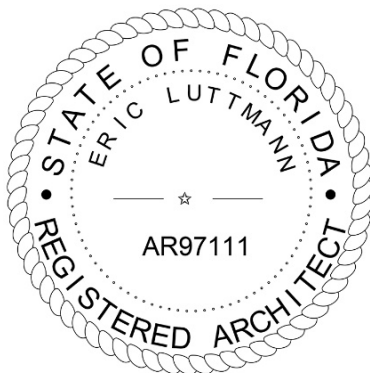
FOR

ARCHITECTURAL/GENERAL

FINANCIAL PROJECT ID: 451524-1-38-01
Escambia County, Florida

I hereby certify that these Technical Special Provisions have been properly prepared by me, or under my responsible charge, in accordance with procedures adopted by the Florida Department of Transportation. Printed copies of this document are not considered signed and sealed and the signature must be verified on any electronic copies.

The official record of this Technical Special Provision is the electronic document signed and sealed under rule 61G1-16.005 F.A.C.



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TECHNICAL SPECIAL PROVISION
FOR
LANDSCAPE ARCHITECTURE

FINANCIAL PROJECT ID: 451524-1-38-01
Escambia County, Florida

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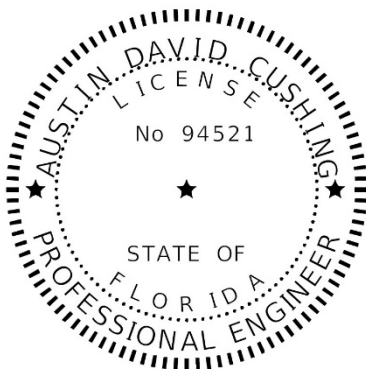
TECHNICAL SPECIAL PROVISION

**FOR
CIVIL**

FINANCIAL PROJECT ID: 451524-1-38-01
Escambia County, Florida

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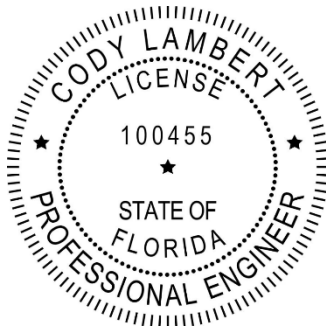
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**TECHNICAL SPECIAL PROVISION
FOR
STRUCTURAL**

FINANCIAL PROJECT ID: 451524-1-38-01
Escambia County, Florida

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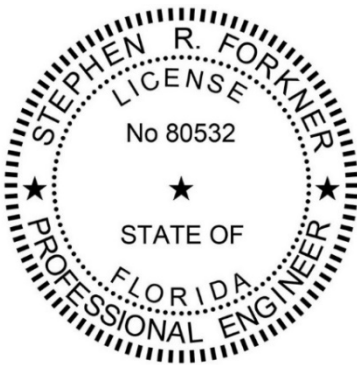
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**TECHNICAL SPECIAL PROVISION
FOR
MECHANICAL/PLUMBING**

FINANCIAL PROJECT ID: 451524-1-38-01
Escambia County, Florida

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TECHNICAL SPECIAL PROVISION

**FOR
ELECTRICAL**

FINANCIAL PROJECT ID: 451524-1-38-01
Escambia County, Florida

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TECHNICAL SPECIAL PROVISION
FOR
SECURITY/TELECOMMUNICATIONS

FINANCIAL PROJECT ID: 451524-1-38-01
Escambia County, Florida

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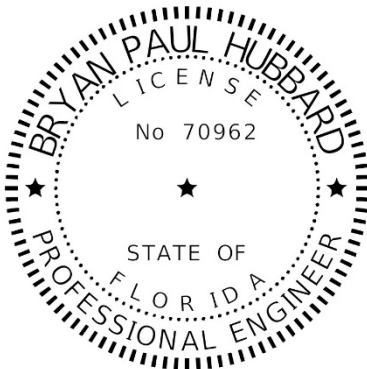
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TECHNICAL SPECIAL PROVISION
FOR
INTEGRATED TECHNOLOGY SYSTEMS

FINANCIAL PROJECT ID: 451524-1-38-01
Escambia County, Florida

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THE FOLLOWING SPECIFICATION SECTIONS ARE ADDED AS A TECHNICAL SPECIAL PROVISION AND SHALL GOVERN BUILDING CONSTRUCTION WORK.

THE LISTED SPECIFICATIONS WERE PREPARED UNDER THE DIRECT SUPERVISION OF THE PERSON SIGNING AND SEALING THE COVER SHEET OF THESE TECHNICAL SPECIAL PROVISIONS FOR THEIR RESPECTIVE DISCIPLINES AND FIRM INDICATED.

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SECTION 01 11 00
SUMMARY OF WORK

PART 1 - GENERAL

1.01 WORK COVERED UNDER CONTRACT DOCUMENTS

- A. The Work, in general, consists of new building construction in Pensacola, FL for the Florida-Alabama TPO.
- B. For additional information concerning acceptance of the Work by the Owner, refer to Technical Special Provision Section 01 77 00 - PROJECT CLOSEOUT.
- C. The method of measurement and basis of payment for each Section is specified in Article 3.01 - MEASUREMENT AND PAYMENT at the end of this Technical Special Provision Section.
- D. The terms Owner and Department are interchangeable.
- E. The terms Architect and Engineer are interchangeable.
- F. For work not included withing Technical Specifications, refer to other plan component sets.

1.02 SECURITY PROVISIONS UNTIL FINAL ACCEPTANCE

- A. Provide security and provisions until the site is opened to traffic. The building shall be maintained in a condition acceptable to the owner for Final Acceptance and occupancy of the facility.
- B. Security provisions shall include, but not be limited to, those measures required to prevent vandalism and theft during construction.
 - 1. All materials required for security provisions may be new or used, but shall be adequate in capacity for required usage, shall not create unsafe conditions, and shall not violate requirements of applicable codes and standards.
- C. Submit a complete, detailed security plan to the Engineer for approval.

1.03 CONTRACTOR'S RESPONSIBILITIES

- A. The requirements of the construction documents shall be fully reviewed, designed, permitted and certified by the Contractor.
- B. The design and construction to be in compliance with all applicable codes, standards and the requirements of the Contract Documents are the responsibility of the Contractor.
- C. Contractor Environmental Commitment
 - 1. The department has determined the following species habitat exists in the project limits and requires the following environmental commitments:

- a. Eastern indigo snake (*drymarchon coraiscouperi*): the most recent version of the U.S. fish and wildlife service standard protection measures for the eastern indigo snake shall be implemented during construction.
 - b. Florida black bear (*ursus americanus floridanus*): therefore, consistent with the FWC black bear management plan, garbage and food debris must be properly removed from the construction site daily to eliminate possible sources of food that could encourage and attract bears. Nuisance black bears are to be reported to the FWC at the wildlife alert hotline at 1-888-404-3922.
 - c. Tricolored bat (*perimyotis subflavus*): if the tricolored bat is listed by USFWS as threatened or endangered and the project may affect the species, FDOT commits to re-initiating consultation with USFWS to determine appropriate avoidance and minimization measures for protection of the newly listed species.
2. Refer to FDOT's Project Development and Environment Manual for further information on Environmental Commitments.

PART 2 - PRODUCTS

2.01 BUY AMERICA BUILD AMERICA ACT REQUIREMENTS (BABA)

- A. Source of Supply—Convict Labor (Federal-Aid Contracts Only): Do not use materials that were produced after July 1, 1991, by convict labor for Federal-aid highway construction projects unless the prison facility has been producing convict-made materials for Federal-aid highway construction projects before July 1, 1987. Use materials that were produced prior to July 2, 1991, by convicts on Federal-aid highway construction projects free from the restrictions placed on the use of these materials by 23 U.S.C. 114. The Department will limit the use of materials produced by convict labor for use in Federal-aid highway construction projects to:
 1. Materials produced by convicts on parole, supervised release, or probation from a prison or;
 2. Materials produced in a qualified prison facility. The amount of such materials produced for Federal-aid highway construction during any 12-month period shall not exceed the amount produced in such facility for use in such construction during the 12-month period ending July 1, 1987.
- B. Source of Supply: Comply with Section 70914 of Public Law No. 117-58, §§ 70901-52, also known as the Infrastructure Investment and Jobs Act (IIJA), Public Law 117-58, which includes the Build America, Buy America Act (BABA). Domestic compliance for all affected products will be listed on the APL.
- C. Steel and Iron: Use steel and iron manufactured in the United States, in accordance with the Buy America provisions of 23 CFR 635.410, as amended. Ensure that all manufacturing processes for this material occur in the United States. As used in this specification, a manufacturing process is any process that modifies the chemical content, physical shape or size, or final finish of a product, beginning with the initial melting and continuing

through the final shaping and coating. If a steel or iron product is taken outside the United States for any manufacturing process, it becomes foreign source material. When using steel or iron materials as a component of any manufactured product (e.g., concrete pipe, prestressed beams, corrugated steel pipe, etc.), these same provisions apply. Foreign steel and iron may be used when the total actual cost of such foreign materials does not exceed 0.1% of the total Contract amount or \$2,500, whichever is greater. These requirements are applicable to all steel and iron materials incorporated into the finished work, but are not applicable to steel and iron items that the Contractor uses but does not incorporate into the finished work. Submit a certification from the manufacturer of steel or iron, or any product containing steel or iron, stating that all steel or iron furnished or incorporated into the furnished product was produced and manufactured in the United States or a statement that the product was produced within the United States except for minimal quantities of foreign steel and iron valued at \$ (actual cost). Submit each such certification to the Engineer prior to incorporating the material or product into the project. Prior to the use of foreign steel or iron materials on a project, submit invoices to document the actual cost of such material, and obtain the Engineer's written approval prior to incorporating the material into the project.

- D. **Manufactured Products:** Use Manufactured Products that are consumed in, incorporated into, or affixed to an infrastructure project that are manufactured in the United States, in accordance with BABA requirements and applicable waivers.
- E. **Construction Materials:** Use non-ferrous metals, plastic and polymerbased products, glass, lumber, and drywall articles, materials, and supplies that are consumed in, incorporated into, or affixed to an infrastructure project that are manufactured in the United States, in accordance with BABA requirements.
- F. **Exemptions to Build America, Buy America:** Temporary devices, equipment, and other items removed at or before the completion of the project are exempt from BABA funding eligibility requirements. Aggregates, cementitious materials, and aggregate binding agents or additives are exempted from BABA funding eligibility requirements.

PART 3 - EXECUTION

3.01 MEASUREMENT AND PAYMENT

- A. **General:** The Work consists of the furnishing of all labor, materials, and equipment necessary to construct the building as shown on the Plans and summarized in this Technical Special Provision Section. This Work shall constitute the "Lump Sum" Building Work, unless otherwise specified or indicated on the Plans and/or specified herein.
- B. **Method of Measurement:**
 - 1. The quantities for the building shall be pursuant to the Lump Sum for the structures including, in general, and the following:
 - a. The building(s), including earthwork, the building foundation(s), the building structure(s), and all materials and facilities within the building(s), as shown on the Plans.
 - b. All civil, structural, architectural, mechanical, plumbing, and electrical in

conjunction with the Building Work.

2. Lump Sum(s) shall include full compensation for furnishing all labor, equipment, tools, and incidentals necessary to complete the Work under each item.
3. Lump Sum(s) shall also include procuring the building permit, and all permits required for the building. The owner will pay the cost of the building permit. Responsibility for re-inspection fees is in accordance with the TSP Section for Permits.
4. Pay Items listed below includes, but not limited to, demolition of existing facilities, new picnic pavilions and the new Building. All appurtenances related to the building herein specified shall be included.

END OF SECTION 01 11 00

SECTION 01 25 00
SUBSTITUTION PROCEDURES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.
- B. SUMMARY OF WORK: Section 01 11 00:
 - 1. Refer to "PART 2 – PRODUCTS" for all Buy America Build America Act (BABA) Requirements

1.02 SUMMARY

- A. Section includes administrative and procedural requirements for substitutions.

1.03 DEFINITIONS

- A. Retain terms that remain after this Section has been edited for a project.
- B. Substitutions: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor.
 - 1. Substitutions for Cause: Changes proposed by Contractor that are required due to changed Project conditions, such as unavailability of product, regulatory changes, or unavailability of required warranty terms.
 - 2. Substitutions for Convenience: Changes proposed by Contractor or Owner that are not required in order to meet other Project requirements but may offer advantage to Contractor or Owner.
- C. Products: Items purchased for incorporating into the Work, whether purchased for Project or taken from previously purchased stock. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.
 - 1. Named Products: Items identified by manufacturer's product name, including make or model number or other designation shown or listed in manufacturer's published product literature that is current as of date of the Contract Documents.
 - 2. New Products: Items that have not previously been incorporated into another project or facility, except that products consisting of recycled-content materials are allowed, unless explicitly stated otherwise. Products salvaged or recycled from other projects are not considered new products.
 - 3. Comparable Product: Product that, in Architect's sole judgment, is demonstrated and approved through submittal process, or where indicated as a product substitution, to have indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product. Requirements for submittal and

conditions for consideration of comparable products are covered in Division 01 Section "Product Requirements."

- D. Basis-of-Design Product Specification: A specification in which a specific manufacturer's product is named and accompanied by the words "basis-of-design product," including make or model number or other designation, to establish the significant qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics for purposes of evaluating comparable products of additional manufacturers named in the specification. Requirements for submittal and conditions for consideration of comparable products are covered in Division 01 Section "Product Requirements."
- E. Non-restricted Products/Manufacturers: A specification which lists two or more products or manufacturers for the convenience of the Contractor; the Contractor however is free to submit any product that complies with the descriptive properties, reference standards, and performance requirements that establish the salient features as the basis for evaluating products. Procedures for substitution requests do not apply when using this method. Approval of unnamed products or the products of unnamed manufacturers is sought through the process for approval of a comparable product as described in Division 01 Section "Product Requirements."

1.04 ACTION SUBMITTALS

- A. Substitution Requests: Submit three copies of each request for consideration. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
 - 1. Substitution Request Form: Use facsimile of form provided in Project Manual.
 - 2. Documentation: Show compliance with requirements for substitutions and the following, as applicable:
 - a. Statement indicating why specified product or fabrication or installation cannot be provided, if applicable.
 - b. Coordination information, including a list of changes or revisions needed to other parts of the Work and to construction performed by Owner and separate contractors that will be necessary to accommodate proposed substitution.
 - c. Detailed comparison of significant qualities of proposed substitution with those of the Work specified. Include annotated copy of applicable Specification Section. Significant qualities may include attributes such as performance, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements indicated. Indicate deviations, if any, from the Work specified.
 - d. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
 - e. Samples, where applicable or requested.

- f. Certificates and qualification data, where applicable or requested.
 - g. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners.
 - h. Material test reports from a qualified testing agency indicating and interpreting test results for compliance with requirements indicated.
 - i. Research reports evidencing compliance with building code in effect for Project, from ICC-ES.
 - j. Detailed comparison of Contractor's construction schedule using proposed substitution with products specified for the Work, including effect on the overall Contract Time. If specified product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating date of receipt of purchase order, lack of availability, or delays in delivery.
 - k. Cost information, including a proposal of change, if any, in the Contract Sum.
 - l. Contractor's certification that proposed substitution complies with requirements in the Contract Documents except as indicated in substitution request, is compatible with related materials, and is appropriate for applications indicated.
 - m. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.
3. Substitutions will not be considered when:
- a. Indicated on shop drawings or product data without separate formal request.
 - b. Requested directly by subcontractor of supplier.
 - c. Acceptance will require substantial revision of Contract Documents.
 - d. Proposed changes are not in keeping with general intent of Contract Documents.
4. By making requests for substitutions, Contractor:
- a. Represents that Contractor has personally investigated proposed substitute product and determined that it is equal to or superior in all respects to that specified.
 - b. Represents that Contractor will provide same warranty for substitution that Contractor would for that specified.
 - c. Will coordinate installation of accepted substitute, making such changes

as may be required for Work to be compatible with substrates and adjacent materials, and complete in all respects.

- d. Waives claims for additional time related to substitution which may later become apparent.
 - e. Certifies that cost data presented is complete and includes related costs under this Contract, including redesign costs, and waives claims for additional costs related to substitution which may later become apparent.
5. Modification of Documents: Where substitution requires, for proper installation, changes to design of Work as indicated on accepted Shop Drawings, furnish drawings and specifications prepared by and bearing seal of licensed architect and engineers as appropriate, revising Contract Documents.
- a. Submit revised Documents for acceptance in accordance with Division 01 Section "Submittal Procedures."
 - b. Revised Drawings: Sufficiently complete for proper installation of substitution and related Work.
 - (1) Include details of connection to and relationship with adjacent materials.
 - c. If, in Architect's sole judgment, proposed substitution is of such significance or deals with product or system affecting basic design or aesthetics, pay Architect for changes required to Contract Documents as determined by contracts.
 - d. Contractor: Responsible for cost of revised Documents, obtaining and paying for review and plan check by authorities having jurisdiction, and cost of revised construction.
 - e. Revised Drawings: Submit with Record Documents in accordance with Division 1 Section "Project Record Documents."
6. Architect's Action: If necessary, Architect will request additional information or documentation for evaluation within seven days of receipt of a request for substitution. Architect will notify Contractor through Construction Manager of acceptance or rejection of proposed substitution within 15 days of receipt of request, or seven days of receipt of additional information or documentation, whichever is later.
- a. Architect or Construction Manager will not make exhaustive attempt to determine products proposed for substitution are equivalent to or can be modified in order to be equivalent to specified products. Where extensive investigation is required by [Construction Manager or] Architect, Contractor is responsible for reimbursing as determined by contracts.
 - b. Form of Acceptance: Change Order, Construction Change Directive, or Architect's Supplemental Instructions for minor changes in the Work.

- c. Use product specified if Architect does not issue a decision on use of a proposed substitution within time allocated.

1.05 QUALITY ASSURANCE

- A. Compatibility of Substitutions: Investigate and document compatibility of proposed substitution with related products and materials. Engage a qualified testing agency to perform compatibility tests recommended by manufacturers.

1.06 PROCEDURES

- A. Coordination: Revise or adjust affected work as necessary to integrate work of the approved substitutions.

PART 2 - PRODUCTS

2.01 SUBSTITUTIONS

- A. Substitutions for Cause: Submit requests for substitution immediately on discovery of need for change, but not later than 15 days prior to time required for preparation and review of related submittals.
 - 1. Conditions: Architect will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Architect will return requests without action, except to record noncompliance with these requirements:
 - a. Requested substitution is consistent with the Contract Documents and will produce indicated results.
 - b. Requested substitution provides sustainable design characteristics that specified product provided for BABA compliancy.
 - c. Substitution request is fully documented and properly submitted.
 - d. Requested substitution will not adversely affect Contractor's construction schedule.
 - e. Requested substitution has received necessary approvals of authorities having jurisdiction.
 - f. Requested substitution is compatible with other portions of the Work.
 - g. Requested substitution has been coordinated with other portions of the Work.
 - h. Requested substitution provides specified warranty.
 - i. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.

B. Substitutions for Convenience: Not allowed.

PART 3 - EXECUTION

3.01 "NOT USED"

END OF SECTION 01 25 00

SECTION 01 29 73
SCHEDULE OF VALUES

PART 1 - GENERAL

1.01 SUMMARY

- A. Submit to the Engineer for approval, a Schedule of Values allocated to the various lump sum portions of the Work, within 15 days after the Notice to Proceed.
- B. Upon request of the Engineer, provide support data that substantiates the correctness of the values.
- C. The Schedule of Values will be used by the Engineer for the purpose of reviewing Lump Sum Contract Items and as a basis for interim or partial payments.
- D. The Schedule of Values shall indicate that one (1) percent of the money due under the Lump Sum Contract is reserved for Project Closeout. It is understood that payment will not be made of this reserve amount until all Project Closeout items have been submitted to the Engineer by the Contractor in a manner and form satisfactory to the Engineer and as provided by this specific Contract.
- E. Project Closeout items are defined as any item that this Contract requires the Contractor to furnish to the Engineer as provided by the Standard Specifications, Supplemental Specifications, Special Provisions, Technical Special Provisions, or the Plans. Examples of such items are Operations and Maintenance Manuals, Systems and Equipment Testing, Owner Personnel Training, Supplies required for initial operation of equipment, Project Record Drawings, Warranties and Guarantees, etc.

1.02 RELATED WORK

- A. PROJECT CLOSEOUT: Section 01 77 00.

1.03 FORM AND CONTENT OF SCHEDULE OF VALUES

- A. The Schedule of Values shall be typed on 8-1/2-inch x 11-inch or 8-1/2-inch x 14-inch white paper. The Contractor's standard forms and computer printout will be considered for approval by the Engineer upon the Contractor's request. The Schedule of Values shall identify the:
 - 1. Title of Project and location.
 - 2. Engineer and Project number.
 - 3. Name and address of Contractor.
 - 4. Contract designation.
 - 5. Date of submission.
- B. The Schedule of Values shall list the installed value of the component parts of each pay item of the Work in sufficient detail to serve as a basis for computing unit prices for

progress payments during construction.

- C. Identify each line item with the number and title of the respective major section of the Technical Special Provisions.
- D. For each major line item, list sub-values of major projects or operations under the item.
- E. For the various portions of the Work, prepare the Schedule of Values such that:
 - 1. Each item shall include proportional amount of the Contractor's overhead and profit.
 - 2. No stored material progress payments will be made for stored materials required for building construction or for any work or equipment items to be incorporated therein, unless approved by the Engineer.
 - 3. For items on which progress payments will be allowed for stored materials, break down the value into:
 - a. The cost of materials, delivered and unloaded, with taxes included.
 - b. The total installed value.
 - 4. Prior to allowed progress payments on stored materials, paid invoices for those materials will be available upon request by the Engineer.
 - 5. For all lump sum related line items, provide separate material and labor breakdowns.
 - 6. A separate line item for Project Closeout shall be provided.

1.04 SUB-SCHEDULE OF UNIT VALUES FOR MATERIALS

- A. Submit a sub-schedule of unit costs and quantities for products on which progress payments are allowed for stored products.
- B. The form of submittal shall parallel that of the Schedule of Values, with each item identified the same as the line item in the Schedule of Values.
- C. The unit quantity for bulk materials shall include an allowance for normal waste.
- D. The unit values for the materials shall be broken down into:
 - 1. Cost of the material, delivered and unloaded at the Site, with taxes included.
 - 2. Copies of paid invoices for component material shall be included with the payment request in which the material first appears.
- E. The unit value multiplied by the quantity listed shall equal the cost of that item in the Schedule of Values.

1.05 REVIEW AND RE-SUBMITTAL

- A. After a review by the Engineer, revise and re-submit the Schedule of Values and Sub-schedule of Material Values as required.
- B. Resubmit the revised Schedules in the same manner.

PART 2 - PRODUCTS

"NOT USED"

PART 3 - EXECUTION

"NOT USED"

END OF SECTION 01 29 73

SECTION 01 32 00
CONSTRUCTION PROGRESS DOCUMENTATION

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes administrative and procedural requirements for documenting the progress of construction during performance of the Work, including the following:
 - 1. Startup construction schedule.
 - 2. Contractor's construction schedule.
 - 3. Construction schedule updating reports.
 - 4. Daily construction reports.
 - 5. Site condition reports.
 - 6. Cost loading and cash flow schedule.
 - 7. Special reports.
- B. Related Requirements:
 - 1. Technical Special Provision 01 33 00 - SUBMITTAL PROCEDURES for submitting schedules and reports.

1.02 DEFINITIONS

- A. Activity: A discrete part of a project that can be identified for planning, scheduling, monitoring, and controlling the construction project. Activities included in a construction schedule consume time and resources.
 - 1. Critical Activity: An activity on the critical path that must start and finish on the planned early start and finish times.
 - 2. Predecessor Activity: An activity that precedes another activity in the network.
 - 3. Successor Activity: An activity that follows another activity in the network.
- B. Cost Loading: The allocation of the schedule of values for the completion of an activity as scheduled. The sum of costs for all activities must equal the total Contract Sum unless otherwise approved by Department.
- C. CPM: Critical path method, which is a method of planning and scheduling a construction project where activities are arranged based on activity relationships. Network calculations determine when activities can be performed and the critical path of Project.
- D. Critical Path: The longest connected chain of interdependent activities through the network schedule that establishes the minimum overall Project duration and contains no float.

- E. Event: The starting or ending point of an activity.
- F. Float: The measure of leeway in starting and completing an activity.
 - 1. Float time is not for the exclusive use or benefit of either Department or Contractor, but is a jointly owned, expiring Project resource available to both parties as needed to meet schedule milestones and Contract completion date.
 - a. Extensions of time for performance required under General Conditions pertaining to equitable time adjustment will be granted only to extent that equitable time adjustment exceeds total float in activity or path of activities affected at time Notice to Proceed was issued for change.
 - b. Use of float suppression techniques such as preferential sequencing or logic, special lead/lag logic restraint, extended activity times or imposed dates shall be cause for rejection of Contractor's Construction Schedule and revisions or updates. Use of float time disclosed or implied by use of alternative float suppression techniques shall be shared as directed by the Department.
 - 2. Free float is the amount of time an activity can be delayed without adversely affecting the early start of the successor activity.
 - 3. Total float is the measure of leeway in starting or completing an activity without adversely affecting the planned Project completion date.
- G. Fragment: A partial or fragmentary network that breaks down activities into smaller activities for greater detail.
- H. Major Area: A story of construction, a separate building, or a similar significant construction element.
- I. Major Subcontractor: For purposes of this Section, major subcontractor is defined as subcontractor or supplier whose subcontract value equals or exceeds 15% percent of value of Contract.
- J. Milestone: A key or critical point in time for reference or measurement.
- K. Network Diagram: A graphic diagram of a network schedule, showing activities and activity relationships.
- L. Resource Loading: The allocation of manpower and equipment necessary for the completion of an activity as scheduled.

1.03 INFORMATIONAL SUBMITTALS

- A. Format for Submittals: Submit required submittals in the following format:
 - 1. Working electronic copy of schedule file, where indicated.
 - 2. PDF electronic file.

3. Two paper copies.
- B. Submittals Schedule: Submit per Division 01 Section "Submittals Procedures."
 - C. Startup construction schedule.
 1. Approval of cost-loaded, startup construction schedule will not constitute approval of schedule of values for cost-loaded activities.
 - D. Startup Network Diagram: Of size required to display entire network for entire construction period. Show logic ties for activities.
 - E. Contractor's Construction Schedule: Initial schedule, of size required to display entire schedule for entire construction period.
 1. Submit a working electronic copy of schedule, using software indicated, and labeled to comply with requirements for submittals. Include type of schedule (initial or updated) and date on label.
 - F. CPM Reports: Concurrent with CPM schedule, submit each of the following reports. Format for each activity in reports shall contain activity number, activity description, cost and resource loading, original duration, remaining duration, early start date, early finish date, late start date, late finish date, and total float in calendar days.
 1. Activity Report: List of all activities sorted by activity number and then early start date, or actual start date if known.
 2. Logic Report: List of preceding and succeeding activities for all activities, sorted in ascending order by activity number and then early start date, or actual start date if known.
 3. Total Float Report: List of all activities sorted in ascending order of total float.
 4. Earnings Report: Compilation of Contractor's total earnings from commencement of the Work until most recent Application for Payment.
 - G. Construction Schedule Updating Reports: Submit with Applications for Payment.
 - H. Daily Construction Reports: Submit at weekly intervals.
 - I. Site Condition Reports: Submit at time of discovery of differing conditions.
 - J. Cost Loading and Cash Flow Schedule: Submit two copies with initial submittal and each update of Contractor's Construction Schedule.
 - K. Material Status Report: Submit two copies with initial submittal and each update of Contractor's Construction Schedule.
 - L. Special Reports: Submit at time of unusual event.
 - M. Qualification Data: For scheduling consultant.

1.04 QUALITY ASSURANCE

- A. Contractor's Construction Scheduler: Employ or retain services of construction scheduler with minimum 5 years' experience as person primarily responsible for preparing and maintaining detailed project schedules and capable of producing reports and diagrams within 24 hours of Department's request.
1. Construction Scheduler shall attend meetings pertaining to scheduling, progress of Work, and alleged delays and time impacts.
- B. Within 5 calendar days after Notice of Award, provide statement to the Department indicating following:
1. Identification, qualifications, and experience of construction scheduler and other members of Contractor's scheduling staff.
 2. References for not less than 3 previous projects on which construction scheduler has utilized scheduling means similar to that required for this project with scheduling requirements equal to or exceeding scheduling requirements specified for this Project.
 3. Description of scheduling system to be utilized.
 4. Department reserve right to disapprove construction scheduler, Contractor's scheduling staff, or scheduling system proposed for Project.
 5. Department reserve right to remove from Project, construction scheduler and any member of Contractor's scheduling staff that is, in Department's opinion, incompetent in scheduling.
- C. Prescheduling Conference: Conduct conference at Project site to comply with requirements in Technical Special Provision 01 31 00 - PROJECT MANAGEMENT AND COORDINATION. Review methods and procedures related to the preliminary construction schedule and Contractor's construction schedule, including, but not limited to, the following:
1. Review software limitations and content and format for reports.
 2. Verify availability of qualified personnel needed to develop and update schedule.
 3. Discuss constraints, including work stages, area separations, interim milestones and partial Department occupancy.
 4. Review delivery dates for Department -furnished products.
 5. Review schedule for work of Department's separate contracts.
 6. Review submittal requirements and procedures.
 7. Review time required for review of submittals and resubmittals.
 8. Review requirements for tests and inspections by independent testing and

inspecting agencies.

9. Review time required for Project closeout and Department startup procedures, including commissioning activities.
10. Review and finalize list of construction activities to be included in schedule.
11. Review procedures for updating schedule.

1.05 COORDINATION

- A. Coordinate preparation and processing of schedules and reports with performance of construction activities and with scheduling and reporting of separate contractors.
- B. Coordinate Contractor's construction schedule with the schedule of values, submittal schedule, progress reports, payment requests, and other required schedules and reports.
 1. Secure time commitments for performing critical elements of the Work from entities involved.
 2. Coordinate each construction activity in the network with other activities and schedule them in proper sequence.

PART 2 - PRODUCTS

2.01 CONTRACTOR'S CONSTRUCTION SCHEDULE, GENERAL

- A. Time of beginning, rate of progress, and date of completion of Work are of essence of this Contract. Work shall be executed with such progress as required to prevent delay to other contractors working on other contracts at Site, if any, Contract milestones, or general completion of Contract.
- B. Responsibility for completion:
 1. Should any activity fail to be completed within 15 calendar days of indicated schedule date, take steps necessary to improve progress at no additional cost to Department including, but not limited to:
 - a. Increase number of working hours per shift, shifts per working day, working days per week, or amount of construction equipment, or any combination of foregoing, sufficiently to substantially eliminate lag in scheduled progress.
 - b. Reschedule sequence of activities to achieve maximum practical concurrent accomplishment of Work activities.
 2. Department may require Contractor to submit for review and approval, at no additional cost to Department, such supplementary progress schedules as may be deemed necessary to demonstrate manner in which progress schedule will be regained.
 3. Failure to comply with specified corrective measures shall be grounds for

determination by the Department that Contractor is not prosecuting Work with such diligence as will ensure completion within time specified and may result in termination of Contractor's right to proceed with Work, or any separable part thereof, in accordance with applicable provisions of General Conditions.

4. Failure to include any element of Work required for performance of Contract shall not excuse Contractor from completing all Work required within applicable time constraints, notwithstanding Department approval of Contractor's Construction Schedule.
- C. Nothing in these requirements shall be deemed to negate or diminish Contractor's authority and responsibility to plan and schedule Work as required, subject to requirements of Contract Documents.
- D. Procedures: Comply with procedures contained in AGC's "Construction Project Planning & Scheduling Guidelines," latest edition.
1. To extent there are conflicts between AGC's publication and Specifications, Specifications shall govern.
- E. Time Frame: Extend schedule from date established for the Notice of Award to date of final completion.
1. Contract completion date shall not be changed by submission of a schedule that shows an early completion date, unless specifically authorized by Change Order.
 2. If Contractor submits Contractor's Construction Schedule showing completion of Work more than 30 calendar days in advance of Contract Completion Date, Department may, at no cost to Department, decrease Contract Time by issuance of Change Order which will change appropriate milestone dates and Contract Completion date to completion date reflected on Contractor's Construction Schedule.
 3. Schedule updates having early completion date shall show time between early completion date and Contract Completion Date as activity labeled "project float."
- F. Activities: Treat each story or separate area as a separate numbered activity for each main element of the Work. Comply with the following:
1. Activity Duration: Define activities so no activity is longer than 20 calendar days, unless specifically allowed by Department.
 2. Procurement Activities: Include procurement process activities for the following long lead items and major items, requiring a cycle of more than 60 calendar days, as separate activities in schedule. Procurement cycle activities include, but are not limited to, submittals, approvals, purchasing, fabrication, and delivery.
 3. Submittal Review Time: Include review and resubmittal times indicated in Section 01 33 00 "Submittal Procedures" in schedule. Coordinate submittal review times in Contractor's construction schedule with submittal schedule.

4. Startup and Testing Time: Include no fewer than 15 days for startup and testing.
 5. Substantial Completion: Indicate completion in advance of date established for Substantial Completion, and allow time for Department administrative procedures necessary for certification of Final Acceptance.
 6. Punch List and Final Completion: Include not more than seven (7) calendar days for completion of punch list items and final completion.
- G. Constraints: Include constraints and work restrictions indicated in the Contract Documents and as follows in schedule, and show how the sequence of the Work is affected.
1. Phasing: Arrange list of activities on schedule by phase.
 2. Work under More Than One Contract: Include a separate activity for each contract.
 3. Work by Department: Include a separate activity for each portion of the Work performed by Department.
 4. Products Ordered in Advance: Include a separate activity for each product. Include delivery date indicated in Technical Special Provision 01 11 00 - SUMMARY OF WORK. Delivery dates indicated stipulate the earliest possible delivery date.
 5. Department -Furnished Products: Include a separate activity for each product. Include delivery date indicated in Technical Special Provision 01 11 00 - SUMMARY OF WORK. Delivery dates indicated stipulate the earliest possible delivery date.
 6. Work Restrictions: Show the effect of the following items on the schedule:
 - a. Coordination with existing construction.
 - b. Limitations of continued occupancies.
 - c. Uninterruptible services.
 - d. Partial occupancy before Final Acceptance.
 - e. Use of premises restrictions.
 - f. Provisions for future construction.
 - g. Seasonal variations.
 - h. Environmental control.
 7. Work Stages: Indicate important stages of construction for each major portion of the Work, including, but not limited to, the following:
 - a. Subcontract awards.
 - b. Submittals.

- c. Purchases.
 - d. Mockups.
 - e. Fabrication.
 - f. Sample testing.
 - g. Deliveries.
 - h. Installation.
 - i. Tests and inspections.
 - j. Adjusting.
 - k. Curing.
 - l. Building flush-out.
 - m. Startup and placement into final use and operation.
8. Construction Areas: Identify each major area of construction for each major portion of the Work. Indicate where each construction activity within a major area must be sequenced or integrated with other construction activities to provide for the following:
- a. Structural completion.
 - b. Temporary enclosure and space conditioning.
 - c. Permanent space enclosure.
 - d. Completion of mechanical installation.
 - e. Completion of electrical installation.
 - f. Substantial Completion.
- H. Milestones: Include milestones indicated in the Contract Documents in schedule, including, but not limited to, the Notice to Proceed, Substantial Completion, and final completion. "Cost Correlation" Paragraph below establishes progress measured in dollar volume of the Work.
- I. Upcoming Work Summary: Prepare summary report indicating activities scheduled to occur or commence prior to submittal of next schedule update. Summarize the following issues:
- 1. Unresolved issues.
 - 2. Unanswered Requests for Information.

3. Rejected or unreturned submittals.
 4. Notations on returned submittals.
 5. Pending modifications affecting the Work and Contract Time.
- J. Recovery Schedule: When periodic update indicates the Work is 14 or more calendar days behind the current approved schedule, submit a separate recovery schedule indicating means by which Contractor intends to regain compliance with the schedule. Indicate changes to working hours, working days, crew sizes, and equipment required achieving compliance, and dating by which recovery will be accomplished.
- K. Computer Scheduling Software: Prepare schedules using current version of a program that has been developed specifically to manage construction schedules.
1. System shall be capable of handling, processing, printing, and plotting data to satisfy requirements of this Section.
 2. Subject to compliance with requirements, use Primavera Project Planner, Version P3 for Windows XP or equivalent scheduling program acceptable to Department. Use latest version or earlier version acceptable to Department.
 3. System shall be capable of producing computer generated reports with following minimum information:
 - a. Activity identification code keyed to Summary Schedule activities.
 - b. Activity number and activity description.
 - c. From date of report, remaining working days left until early finish of each activity.
 - d. Activity percent complete.
 - e. Activity duration.
 - f. Early start/finish and late start/finish.
 - g. Actual start date/finish date.
 - h. Total float.
 - i. Free float.
 - j. Predecessor and successor activities for each individual activity including precedence logic relationships.
 - k. Comparison between current update and baseline schedule.
 - l. Critical Item List of activities with 14 calendar days or less total float.
 - m. Scheduled and actual labor for each activity.

- n. Scheduled and actual progress payment for each activity.
 - 4. Use logic retain methodology at all times for schedule and float calculation.
 - 5. Software shall be capable of compiling total dollar value of complete and partially complete activities.
 - 6. Software shall be capable of accepting revised completion dates, as modified by approved time extensions, and re-computing activities dates and float accordingly.
- L. Use hardware system commensurate with size of Project, subject to Department.

2.02 STARTUP CONSTRUCTION SCHEDULE

- A. Bar-Chart Schedule: Submit startup, horizontal, bar-chart-type construction schedule within seven days of date established for the Notice of Award.
- B. Preparation: Indicate each significant construction activity separately. Identify first workday of each week with a continuous vertical line. Outline significant construction activities for first 90 calendar days of construction. Include skeleton diagram for the remainder of the Work and a cash requirement prediction based on indicated activities.

2.03 PRELIMINARY CONSTRUCTION SCHEDULE

- A. Prepare Preliminary Construction Schedule covering first 90 calendar days following Notice to Proceed as well as skeleton network diagram for remainder of Work.
 - 1. Show work tasks that will or may affect completion dates including, but not limited to:
 - a. Planning.
 - b. Mobilization.
 - c. Key shop drawing and sample submittals.
 - d. Fabrication and delivery of key and long-lead procurement elements.
 - e. Activities of Department, other contractors, utilities, tenants, or other third parties.
- B. Concurrent with and as part of Preliminary Construction Schedule, submit schedule of manpower and costs assigned to each activity on Preliminary Construction Schedule.
 - 1. Costs assigned shall conform to bid item unit prices, and lump sum bid item breakdown acceptable to Department.
 - 2. Schedule of manpower and costs shall be realistic and level so as to not have any unusual manpower requirements.
- C. Submit to Department within 14 calendar days after Prescheduling Conference.

- D. Meet with Department within 7 calendar days after submittal to review and make necessary adjustments or revisions.
- E. Submit revised Preliminary Construction Schedule within 7 calendar days after meeting for Department approval.
- F. Revised Preliminary Construction Schedule represents Contractor's planned means, methods, and sequences for performance of Work during specified period and shall be incorporated into Contractor's Construction Schedule.
- G. No Work shall be performed prior to submittal and Department approval of preliminary project schedule, including manpower and cost reports.
 - 1. Submittal and Department approval of preliminary project schedule, including manpower and cost reports and other appropriate reports and network diagrams subsequently specified in article titled "Contractor's Construction Schedule as required by Department, is a condition precedent to issuance and payment of initial Application for Payment.
- H. Update schedule monthly during specified period, as part of payment application process.
 - 1. Submit appropriate reports and network diagrams as required by Department.

2.04 CONTRACTOR'S CONSTRUCTION SCHEDULE (CPM SCHEDULE)

- A. Submittal Requirements:
 - 1. Fifteen days after submittal of revised Preliminary Construction Schedule, meet with Department to review progress in development of summary schedule and Contractor's Construction Schedule.
 - 2. Submit Contractor's Construction Schedule within 30 calendar days after submittal of revised Preliminary Construction Schedule.
 - 3. Meet with Department within 7 calendar days after submittal to review and make necessary adjustments or revisions.
 - a. Comments made by Department will not relieve Contractor from compliance with requirements of Contract Documents.
 - 4. Submit revised Contractor's Construction Schedule within 7 calendar days after meeting for Department approval.
- B. To the extent that there are conflicts between detailed project schedule and requirements of Contract Documents, Contract Documents govern.
- C. Startup Network Diagram: Submit diagram within 14 calendar days of date established for the Notice of Award. Outline significant construction activities for the first 90 calendar days of construction. Include skeleton diagram for the remainder of the Work and a cash requirement prediction based on indicated activities.
- D. CPM Schedule: Prepare Contractor's construction schedule using a cost-and resource-

loaded, time-scaled CPM network analysis diagram for the Work.

1. Develop network diagram in sufficient time to submit CPM schedule so it can be accepted for use no later than 30 calendar days after date established for the Notice of Award.
 - a. Failure to include any work item required for performance of this Contract shall not excuse Contractor from completing all work within applicable completion dates, regardless of Department 's approval of the schedule.
 2. Conduct educational workshops to train and inform key Project personnel, including subcontractors' personnel, in proper methods of providing data and using CPM schedule information.
 3. Establish procedures for monitoring and updating CPM schedule and for reporting progress. Coordinate procedures with progress meeting and payment request dates.
 4. Use "calendar days" as the unit of time for individual activities. Indicate nonworking days and holidays incorporated into the schedule in order to coordinate with the Contract Time.
- A. Activities in Contractor's Construction Schedule shall be grouped to enable "rollup" to activities in summary schedule.
1. Summary schedule shall be in bar chart format, time scaled in calendar days from Notice to Proceed, with critical path identified.
 2. Summary schedule shall clearly delineate construction activities for each phase and summary schedule shall contain, but is not limited to:
 - a. Legend of scheduled activities based on early start/finish.
 - b. Department's and Contractor's scheduled milestones.
 - c. Scheduled summary activities shall clearly indicate scope of Work to be completed.
 - d. Submit summary schedule as required for Contractor's Construction Schedule.
- E. CPM Schedule Preparation: Prepare a list of all activities required to complete the Work. Using the startup network diagram, prepare a skeleton network to identify probable critical paths.
1. Activities: Indicate the estimated time duration, sequence requirements, and relationship of each activity in relation to other activities. Include estimated time frames for the following activities:
 - a. Preparation and processing of submittals.
 - b. Mobilization and demobilization.
 - c. Temporary construction support installations.

- d. Demolition and removals.
 - e. Excavation, backfill, and related earthwork activities.
 - f. Submittal preparation and review.
 - g. Order, manufacture, delivery, tests, and installation of critical material and major components, including material to be furnished by Department for installation by Contractor.
 - h. Other major construction activities.
 - i. Purchase of materials.
 - j. Delivery.
 - k. Fabrication.
 - l. Utility interruptions.
 - m. Installation.
 - n. Work by Department that may affect or be affected by Contractor's activities.
 - o. Resource loading for cost, manpower, material, and equipment.
 - p. Allowance for inclement weather and similar conditions.
 - q. Approvals and notices required by regulatory agencies and other third parties.
 - r. Punch-out and acceptance of Work including start-up, testing, and inspection, and commissioning.
 - s. Limits imposed by scope of Work, with contractually specified intermediate milestone and completion dates, and with constraints, restraints, or sequences included in Contract.
 - t. Final clean-up.
 - u. Planning for phased or total takeover by Department.
 - v. Activities occurring following final completion.
2. Critical Path Activities: Identify critical path activities, including those for interim completion dates. Scheduled start and completion dates shall be consistent with Contract milestone dates.
 3. Processing: Process data to produce output data on a computer-drawn, time-scaled network. Revise data, reorganize activity sequences, and reproduce as often as necessary to produce the CPM schedule within the limitations of the Contract

Time.

4. Format: Mark the critical path. Locate the critical path near center of network; locate paths with most float near the edges.
 - a. Subnetworks on separate sheets are permissible for activities clearly off the critical path.
5. Cost-and Resource-Loading of CPM Schedule: Assign cost to construction activities on the CPM schedule. Do not assign costs to submittal activities. Obtain Department approval prior to assigning costs to fabrication and delivery activities. Assign costs under main subcontracts for testing and commissioning activities, operation and maintenance manuals, punch list activities,
 - a. Each activity cost shall reflect an appropriate value subject to approval by Department.
 - b. Total cost assigned to activities shall equal the total Contract Sum.
- F. Contract Modifications: For each proposed contract modification and concurrent with its submission, prepare a time-impact analysis using a network fragment to demonstrate the effect of the proposed change on the overall project schedule.
- G. Initial Issue of Schedule: Prepare initial network diagram from a sorted activity list indicating straight "early start-total float." Identify critical activities. Prepare tabulated reports showing the following:
 1. Contractor or subcontractor and the Work or activity.
 2. Description of activity.
 3. Main events of activity.
 4. Immediate preceding and succeeding activities.
 5. Early and late start dates.
 6. Early and late finish dates.
 7. Activity duration in workdays.
 8. Total float or slack time.
 9. Average size of workforce.
 10. Dollar value of activity (coordinated with the schedule of values).
 11. Sublisting of materials and equipment sorted by specification section number. Sublisting of materials and equipment shall include following activities.
 - a. Preparation of shop drawings and submittal to Department.

- b. Fabrication, testing, and delivery of material and equipment which shall be interfaced with earliest start date that material or equipment is to be installed on Project.
- H. Schedule Updating: Concurrent with making revisions to schedule, prepare tabulated reports showing the following:
 - 1. Identification of activities that have changed.
 - 2. Changes in early and late start dates.
 - 3. Changes in early and late finish dates.
 - 4. Changes in activity durations in workdays.
 - 5. Changes in the critical path.
 - 6. Changes in total float or slack time.
 - 7. Changes in the Contract Time.
- I. Value Summaries: Prepare two cumulative value lists, sorted by finish dates.
 - 1. In first list, tabulate activity number, early finish date, dollar value, and cumulative dollar value.
 - 2. In second list, tabulate activity number, late finish date, dollar value, and cumulative dollar value.
 - 3. In subsequent issues of both lists, substitute actual finish dates for activities completed as of list date.
 - 4. Prepare list for ease of comparison with payment requests; coordinate timing with progress meetings.
 - a. In both value summary lists, tabulate "actual percent complete" and "cumulative value completed" with total at bottom.
 - b. Submit value summary printouts one week before each regularly scheduled progress meeting.

2.05 AS BUILT SCHEDULE

- A. As a condition precedent to release of retention, last update to Contractor's Construction Schedule shall be identified as "As Built Schedule" and shall reflect exact manner in which project was actually constructed, including start and completion dates, activities, sequences, and logic.
 - 1. As built schedule shall be signed and certified by Contractor and construction scheduler as being true reflection of manner in which Project was actually constructed.

2.06 REPORTS

- A. Daily Construction Reports: Prepare a daily construction report recording the following information concerning events at Project site:
1. List of subcontractors at Project site.
 2. List of separate contractors at Project site.
 3. Approximate count of personnel at Project site.
 4. High and low temperatures and general weather conditions, including presence of rain or snow.
 5. Accidents.
 6. Meetings and significant decisions.
 7. Unusual events (see special reports).
 8. Stoppages, delays, shortages, and losses.
 9. Emergency procedures.
 10. Orders and requests of authorities having jurisdiction.
 11. Change Orders received and implemented.
 12. Construction and Work Change Directives received and implemented.
 13. Services connected and disconnected.
 14. Equipment or system tests and startups.
 15. Partial completions and occupancies.
 16. Substantial Completions authorized.
- B. Site Condition Reports: Immediately on discovery of a difference between site conditions and the Contract Documents, prepare and submit a detailed report. Submit with a Request for Information. Include a detailed description of the differing conditions, together with recommendations for changing the Contract Documents.
- C. Cost Loading and Cash Flow Schedule:
1. With initial detailed project schedule submittal and each update, submit schedule of cost loading and cash flow.
 - a. Each individual activity within detailed project schedule shall employ code which, in summary, attaches its cost, if any, to appropriate bid items.
 - b. Sum of activity costs within specific code shall equal cost of

corresponding bid items and approved Change Orders.

2. Submit payment request for each month with proposed updates as well as cumulative payment requests to date for each month of Project.
 - a. Show net payment request for each month and cumulative payment requests to date after deducting retainage and other monies withheld.
 - b. Show cash flow in tabular and graphic format.

2.07 SPECIAL REPORTS

- A. General: Submit special reports directly to Department within one day(s) of an occurrence. Distribute copies of report to parties affected by the occurrence.
- B. Reporting Unusual Events: When an event of an unusual and significant nature occurs at Project site, whether or not related directly to the Work, prepare and submit a special report. List chain of events, persons participating, response by Contractor's personnel, evaluation of results or effects, and similar pertinent information. Advise Department in advance when these events are known or predictable.

PART 3 - EXECUTION

3.01 CONTRACTOR'S CONSTRUCTION SCHEDULE

- A. Scheduling Consultant: Engage a consultant to provide planning, evaluation, and reporting using CPM scheduling.
 1. In-House Option: Department may waive the requirement to retain a consultant if Contractor employs skilled personnel with experience in CPM scheduling and reporting techniques. Submit qualifications.
 2. Meetings: Scheduling consultant shall attend all meetings related to Project progress, alleged delays, and time impact.
- B. Contractor's Construction Schedule Updating: At monthly intervals, update schedule to reflect actual construction progress and activities. Issue schedule one week before each regularly scheduled progress meeting.
 1. Revise schedule immediately after each meeting or other activity where revisions have been recognized or made. Issue updated schedule concurrently with the report of each such meeting.
 2. Include a report with updated schedule that indicates every change, including, but not limited to, changes in logic, durations, actual starts and finishes, and activity durations.
 3. As the Work progresses, indicate final completion percentage for each activity.
- C. Distribution: Distribute copies of approved schedule to Department, separate contractors, testing and inspecting agencies, and other parties identified by Contractor with a need-to-know schedule responsibility.

1. Post copies in Project meeting rooms and temporary field offices.
2. When revisions are made, distribute updated schedules to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned portion of the Work and are no longer involved in performance of construction activities.

END OF SECTION 01 32 00

SECTION 01 42 00
REFERENCES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.02 DEFINITIONS

- A. General: Basic Contract definitions are included in the Conditions of the Contract.
- B. "Approved": When used to convey Architect's action on Contractor's submittals, applications, and requests, "approved" is limited to Architect's duties and responsibilities as stated in the Conditions of the Contract.
- C. "Directed": A command or instruction by Architect. Other terms including "requested," "authorized," "selected," "required," and "permitted" have the same meaning as "directed."
- D. "Indicated": Requirements expressed by graphic representations or in written form on Drawings, in Specifications, and in other Contract Documents. Other terms including "shown," "noted," "scheduled," and "specified" have the same meaning as "indicated."
- E. "Regulations": Laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, and rules, conventions, and agreements within the construction industry that control performance of the Work.
- F. "Furnish": Supply and deliver to Project site, ready for unloading, unpacking, assembly, installation, and similar operations.
- G. "Install": Unload, temporarily store, unpack, assemble, erect, place, anchor, apply, work to dimension, finish, cure, protect, clean, and similar operations at Project site.
- H. "Provide": Furnish and install, complete and ready for the intended use.
- I. "Project Site": Space available for performing construction activities. The extent of Project site is shown on Drawings and may or may not be identical with the description of the land on which Project is to be built.

1.03 INDUSTRY STANDARDS

- A. Applicability of Standards: Unless the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into the Contract Documents to the extent referenced. Such standards are made a part of the Contract Documents by reference.
- B. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.
- C. Copies of Standards: Each entity engaged in construction on Project should be familiar

with industry standards applicable to its construction activity. Copies of applicable standards are not bound with the Contract Documents.

1. Where copies of standards are needed to perform a required construction activity, obtain copies directly from publication source.

1.04 ABBREVIATIONS AND ACRONYMS

A. Industry Organizations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities indicated in Gale's "Encyclopedia of Associations: National Organizations of the U.S." or in Columbia Books' "National Trade & Professional Associations of the United States."

B. Industry Organizations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. This information is subject to change and is believed to be accurate as of the date of the Contract Documents.

1. AABC - Associated Air Balance Council; www.aabc.com.
2. AAMA - American Architectural Manufacturers Association; www.aamanet.org.
3. AAPFCO - Association of American Plant Food Control Officials; www.aapfco.org.
4. AASHTO - American Association of State Highway and Transportation Officials; www.transportation.org.
5. AATCC - American Association of Textile Chemists and Colorists; www.aatcc.org.
6. ABMA - American Bearing Manufacturers Association; www.americanbearings.org.
7. ACI - American Concrete Institute; (Formerly: ACI International); www.concrete.org.
8. ACPA - American Concrete Pipe Association; www.concrete-pipe.org.
9. AEIC - Association of Edison Illuminating Companies, Inc. (The); www.aeic.org.
10. AF&PA - American Forest & Paper Association; www.afandpa.org.
11. AGA - American Gas Association; www.aga.org.
12. AHAM - Association of Home Appliance Manufacturers; www.aham.org.
13. AHRI - Air-Conditioning, Heating, and Refrigeration Institute (The); www.ahrinet.org.
14. AI - Asphalt Institute; www.asphaltinstitute.org.

15. AIA - American Institute of Architects (The); www.aia.org.
16. AISC - American Institute of Steel Construction; www.aisc.org.
17. AISI - American Iron and Steel Institute; www.steel.org.
18. AITC - American Institute of Timber Construction; www.aitc-glulam.org.
19. AMCA - Air Movement and Control Association International, Inc.; www.amca.org.
20. ANSI - American National Standards Institute; www.ansi.org.
21. APA - APA - The Engineered Wood Association; www.apawood.org.
22. APA - Architectural Precast Association; www.archprecast.org.
23. ARI - Air-Conditioning & Refrigeration Institute; (See AHRI).
24. ARI - American Refrigeration Institute; (See AHRI).
25. ARMA - Asphalt Roofing Manufacturers Association; www.asphaltroofing.org.
26. ASCE - American Society of Civil Engineers; www.asce.org.
27. ASCE/SEI - American Society of Civil Engineers/Structural Engineering Institute; (See ASCE).
28. ASHRAE - American Society of Heating, Refrigerating and Air-Conditioning Engineers; www.ashrae.org.
29. ASME - ASME International; (American Society of Mechanical Engineers); www.asme.org.
30. ASSE - American Society of Safety Engineers (The); www.asse.org.
31. ASSE - American Society of Sanitary Engineering; www.asse-plumbing.org.
32. ASTM - ASTM International; (American Society for Testing and Materials International); www.astm.org.
33. ATIS - Alliance for Telecommunications Industry Solutions; www.atis.org.
34. AWEA - American Wind Energy Association; www.awea.org.
35. AWI - Architectural Woodwork Institute; www.awinet.org.
36. AWMAC - Architectural Woodwork Manufacturers Association of Canada; www.awmac.com.
37. AWPA - American Wood Protection Association; (Formerly: American Wood-Preservers' Association); www.awpa.com.

38. AWS - American Welding Society; www.aws.org.
39. AWWA - American Water Works Association; www.awwa.org.
40. BABA – Buy America Build America; www.commerce.gov/oam/build-america-buy-america
41. BHMA - Builders Hardware Manufacturers Association; www.buildershardware.com.
42. BIA - Brick Industry Association (The); www.gobrick.com.
43. BICSI - BICSI, Inc.; www.bicsi.org.
44. BIFMA - BIFMA International; (Business and Institutional Furniture Manufacturer's Association); www.bifma.com.
45. BISSC - Baking Industry Sanitation Standards Committee; www.bissc.org.
46. BWF - Badminton World Federation; (Formerly: International Badminton Federation); www.bwfbadminton.org.
47. CDA - Copper Development Association; www.copper.org.
48. CEA - Canadian Electricity Association; www.electricity.ca.
49. CEA - Consumer Electronics Association; www.ce.org.
50. CFFA - Chemical Fabrics & Film Association, Inc.; www.chemicalfabricsandfilm.com.
51. CFSEI - Cold-Formed Steel Engineers Institute; www.cfsei.org.
52. CGA - Compressed Gas Association; www.cganet.com.
53. CIMA - Cellulose Insulation Manufacturers Association; www.cellulose.org.
54. CISCA - Ceilings & Interior Systems Construction Association; www.cisca.org.
55. CISPI - Cast Iron Soil Pipe Institute; www.cispi.org.
56. CLFMI - Chain Link Fence Manufacturers Institute; www.chainlinkinfo.org.
57. CPA - Composite Panel Association; www.pbmdf.com.
58. CRI - Carpet and Rug Institute (The); www.carpet-rug.org.
59. CRRC - Cool Roof Rating Council; www.coolroofs.org.
60. CRSI - Concrete Reinforcing Steel Institute; www.crsi.org.
61. CSA - Canadian Standards Association; www.csa.ca.

62. CSA - CSA International; (Formerly: IAS - International Approval Services); www.csa-international.org.
63. CSI - Construction Specifications Institute (The); www.csinet.org.
64. CSSB - Cedar Shake & Shingle Bureau; www.cedarbureau.org.
65. CTI - Cooling Technology Institute; (Formerly: Cooling Tower Institute); www.cti.org.
66. CWC - Composite Wood Council; (See CPA).
67. DASMA - Door and Access Systems Manufacturers Association; www.dasma.com.
68. DHI - Door and Hardware Institute; www.dhi.org.
69. ECA - Electronic Components Association; (See ECIA).
70. ECAMA - Electronic Components Assemblies & Materials Association; (See ECIA).
71. ECIA - Electronic Components Industry Association; www.eciaonline.org
72. EIA - Electronic Industries Alliance; (See TIA).
73. EIMA - EIFS Industry Members Association; www.eima.com.
74. EJMA - Expansion Joint Manufacturers Association, Inc.; www.ejma.org.
75. ESD - ESD Association; (Electrostatic Discharge Association); www.esda.org.
76. ESTA - Entertainment Services and Technology Association; (See PLASA).
77. EVO - Efficiency Valuation Organization; www.evo-world.org.
78. FM Approvals - FM Approvals LLC; www.fmglobal.com.
79. FM Global - FM Global; (Formerly: FMG - FM Global); www.fmglobal.com.
80. FRSA - Florida Roofing, Sheet Metal & Air Conditioning Contractors Association, Inc.; www.floridarroof.com.
81. FSA - Fluid Sealing Association; www.fluidsealing.com.
82. FSC - Forest Stewardship Council U.S.; www.fscus.org.
83. GA - Gypsum Association; www.gypsum.org.
84. GANA - Glass Association of North America; www.glasswebsite.com.
85. GS - Green Seal; www.green Seal.org.

86. HI - Hydraulic Institute; www.pumps.org.
87. HI/GAMA - Hydronics Institute/Gas Appliance Manufacturers Association; (See AHRI).
88. HMMA - Hollow Metal Manufacturers Association; (See NAAMM).
89. HPVA - Hardwood Plywood & Veneer Association; www.hpva.org.
90. HPW - H. P. White Laboratory, Inc.; www.hpwhite.com.
91. IAPSC - International Association of Professional Security Consultants; www.iapsc.org.
92. IAS - International Accreditation Service; www.iasonline.org.
93. IAS - International Approval Services; (See CSA).
94. ICBO - International Conference of Building Officials; (See ICC).
95. ICC - International Code Council; www.iccsafe.org.
96. ICEA - Insulated Cable Engineers Association, Inc.; www.icea.net.
97. ICPA - International Cast Polymer Alliance; www.icpa-hq.org.
98. ICRI - International Concrete Repair Institute, Inc.; www.icri.org.
99. IEC - International Electrotechnical Commission; www.iec.ch.
100. IEEE - Institute of Electrical and Electronics Engineers, Inc. (The); www.ieee.org.
101. IES - Illuminating Engineering Society; (Formerly: Illuminating Engineering Society of North America); www.ies.org.
102. IESNA - Illuminating Engineering Society of North America; (See IES).
103. IEST - Institute of Environmental Sciences and Technology; www.iest.org.
104. IGMA - Insulating Glass Manufacturers Alliance; www.igmaonline.org.
105. IGSHPA - International Ground Source Heat Pump Association; www.igshpa.okstate.edu.
106. ILI - Indiana Limestone Institute of America, Inc.; www.iliai.com.
107. Intertek - Intertek Group; (Formerly: ETL SEMCO; Intertek Testing Service NA); www.intertek.com.
108. ISA - International Society of Automation (The); (Formerly: Instrumentation, Systems, and Automation Society); www.isa.org.

109. ISAS - Instrumentation, Systems, and Automation Society (The); (See ISA).
110. ISFA - International Surface Fabricators Association; (Formerly: International Solid Surface Fabricators Association); www.isfanow.org.
111. ISO - International Organization for Standardization; www.iso.org.
112. ISSFA - International Solid Surface Fabricators Association; (See ISFA).
113. ITU - International Telecommunication Union; www.itu.int/home.
114. KCMA - Kitchen Cabinet Manufacturers Association; www.kcma.org.
115. LMA - Laminating Materials Association; (See CPA).
116. LPI - Lightning Protection Institute; www.lightning.org.
117. MBMA - Metal Building Manufacturers Association; www.mbma.com.
118. MCA - Metal Construction Association; www.metalconstruction.org.
119. MFMA - Maple Flooring Manufacturers Association, Inc.; www.maplefloor.org.
120. MFMA - Metal Framing Manufacturers Association, Inc.; www.metalframingmfg.org.
121. MHIA - Material Handling Industry of America; www.mhia.org.
122. MIA - Marble Institute of America; www.marble-institute.com.
123. MMPA - Moulding & Millwork Producers Association; (Formerly: Wood Moulding & Millwork Producers Association); www.wmmpa.com.
124. MPI - Master Painters Institute; www.paintinfo.com.
125. MSS - Manufacturers Standardization Society of The Valve and Fittings Industry Inc.; www.mss-hq.org.
126. NAAMM - National Association of Architectural Metal Manufacturers; www.naamm.org.
127. NACE - NACE International; (National Association of Corrosion Engineers International); www.nace.org.
128. NADCA - National Air Duct Cleaners Association; www.nadca.com.
129. NAIMA - North American Insulation Manufacturers Association; www.naima.org.
130. NCMA - National Concrete Masonry Association; www.ncma.org.
131. NEBB - National Environmental Balancing Bureau; www.nebb.org.

132. NECA - National Electrical Contractors Association; www.necanet.org.
133. NeLMA - Northeastern Lumber Manufacturers Association; www.nelma.org.
134. NEMA - National Electrical Manufacturers Association; www.nema.org.
135. NETA - InterNational Electrical Testing Association; www.netaworld.org.
136. NFHS - National Federation of State High School Associations; www.nfhs.org.
137. NFPA - NFPA; (National Fire Protection Association); www.nfpa.org.
138. NFPA - NFPA International; (See NFPA).
139. NFRC - National Fenestration Rating Council; www.nfrc.org.
140. NHLA - National Hardwood Lumber Association; www.nhla.com.
141. NLGA - National Lumber Grades Authority; www.nlga.org.
142. NOFMA - National Oak Flooring Manufacturers Association; (See NWFA).
143. NOMMA - National Ornamental & Miscellaneous Metals Association; www.nomma.org.
144. NRCA - National Roofing Contractors Association; www.nrca.net.
145. NRMCA - National Ready Mixed Concrete Association; www.nrmca.org.
146. NSF - NSF International; (National Sanitation Foundation International); www.nsf.org.
147. NSPE - National Society of Professional Engineers; www.nspe.org.
148. NSSGA - National Stone, Sand & Gravel Association; www.nssga.org.
149. NTMA - National Terrazzo & Mosaic Association, Inc. (The); www.ntma.com.
150. NWFA - National Wood Flooring Association; www.nwfa.org.
151. PCI - Precast/Prestressed Concrete Institute; www.pci.org.
152. PDI - Plumbing & Drainage Institute; www.pdionline.org.
153. RCSC - Research Council on Structural Connections; www.boltcouncil.org.
154. RFCI - Resilient Floor Covering Institute; www.rfci.com.
155. SCTE - Society of Cable Telecommunications Engineers; www.scte.org.
156. SDI - Steel Deck Institute; www.sdi.org.

157. SDI - Steel Door Institute; www.steeldoor.org.
158. SEFA - Scientific Equipment and Furniture Association; www.sefalabs.com.
159. SEI/ASCE - Structural Engineering Institute/American Society of Civil Engineers; (See ASCE).
160. SIA - Security Industry Association; www.siaonline.org.
161. SJI - Steel Joist Institute; www.steeljoist.org.
162. SMA - Screen Manufacturers Association; www.smainfo.org.
163. SMACNA - Sheet Metal and Air Conditioning Contractors' National Association; www.smacna.org.
164. SMPTE - Society of Motion Picture and Television Engineers; www.smpte.org.
165. SPFA - Spray Polyurethane Foam Alliance; www.sprayfoam.org.
166. SPIB - Southern Pine Inspection Bureau; www.spib.org.
167. SPRI - Single Ply Roofing Industry; www.spri.org.
168. SRCC - Solar Rating and Certification Corporation; www.solar-rating.org.
169. SSINA - Specialty Steel Industry of North America; www.ssina.com.
170. SSPC - SSPC: The Society for Protective Coatings; www.sspc.org.
171. STI - Steel Tank Institute; www.steeltank.com.
172. SWI - Steel Window Institute; www.steelwindows.com.
173. SWPA - Submersible Wastewater Pump Association; www.swpa.org.
174. TCA - Tilt-Up Concrete Association; www.tilt-up.org.
175. TCNA - Tile Council of North America, Inc.; (Formerly: Tile Council of America); www.tileusa.com.
176. TEMA - Tubular Exchanger Manufacturers Association, Inc.; www.tema.org.
177. TIA - Telecommunications Industry Association; (Formerly: TIA/EIA - Telecommunications Industry Association/Electronic Industries Alliance); www.tiaonline.org.
178. TIA/EIA - Telecommunications Industry Association/Electronic Industries Alliance; (See TIA).
179. TMS - The Masonry Society; www.masonrysociety.org.

- 180. TPI - Truss Plate Institute; www.tpinst.org.
- 181. TPI - Turfgrass Producers International; www.turfgrassod.org.
- 182. TRI - Tile Roofing Institute; (Formerly: National Tile Roofing Manufacturing Association); www.tilerroofing.org.
- 183. UBC - Uniform Building Code; (See ICC).
- 184. UL - Underwriters Laboratories Inc.; www.ul.com.
- 185. UNI - Uni-Bell PVC Pipe Association; www.uni-bell.org.
- 186. USAV - USA Volleyball; www.usavolleyball.org.
- 187. USITT - United States Institute for Theatre Technology, Inc.; www.usitt.org.
- 188. WASTEC - Waste Equipment Technology Association; www.wastec.org.
- 189. WCLIB - West Coast Lumber Inspection Bureau; www.wclib.org.
- 190. WCMA - Window Covering Manufacturers Association; www.wcmanet.org.
- 191. WDMA - Window & Door Manufacturers Association; www.wdma.com.
- 192. WI - Woodwork Institute; (Formerly: WIC - Woodwork Institute of California); www.wicnet.org.
- 193. WMMPA - Wood Molding & Millwork Producers Association; (See MMPA).
- 194. WSRCA - Western States Roofing Contractors Association; www.wsrca.com.
- 195. WPA - Western Wood Products Association; www.wwpa.org.

C. Code Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. This information is believed to be accurate as of the date of the Contract Documents.

- 1. IAPMO - International Association of Plumbing and Mechanical Officials; www.iapmo.org.
- 2. ICC - International Code Council; www.iccsafe.org.
- 3. ICC-ES - ICC Evaluation Service, LLC; www.icc-es.org.

D. Federal Government Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. Information is subject to change and is up-to-date as of the date of the Contract Documents.

- 1. COE - Army Corps of Engineers; www.usace.army.mil.

2. CPSC - Consumer Product Safety Commission; www.cpsc.gov.
3. DOC - Department of Commerce; National Institute of Standards and Technology; www.nist.gov.
4. DOD - Department of Defense; <http://dodssp.daps.dla.mil>.
5. DOE - Department of Energy; www.energy.gov.
6. EPA - Environmental Protection Agency; www.epa.gov.
7. FAA - Federal Aviation Administration; www.faa.gov.
8. FG - Federal Government Publications; www.gpo.gov.
9. GSA - General Services Administration; www.gsa.gov.
10. HUD - Department of Housing and Urban Development; www.hud.gov.
11. LBL - Lawrence Berkeley National Laboratory; Environmental Energy Technologies Division; <http://eetd.lbl.gov>.
12. OSHA - Occupational Safety & Health Administration; www.osha.gov.
13. SD - Department of State; www.state.gov.
14. TRB - Transportation Research Board; National Cooperative Highway Research Program; www.trb.org.
15. USDA - Department of Agriculture; Agriculture Research Service; U.S. Salinity Laboratory; www.ars.usda.gov.
16. USDA - Department of Agriculture; Rural Utilities Service; www.usda.gov.
17. USDJ - Department of Justice; Office of Justice Programs; National Institute of Justice; www.ojp.usdoj.gov.
18. USP - U.S. Pharmacopeia; www.usp.org.
19. USPS - United States Postal Service; www.usps.com.

E. Standards and Regulations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the standards and regulations in the following list. This information is subject to change and is believed to be accurate as of the date of the Contract Documents.

1. CFR - Code of Federal Regulations; Available from Government Printing Office; www.gpo.gov/fdsys.
2. DOD - Department of Defense; Military Specifications and Standards; Available from Department of Defense Single Stock Point; <http://dodssp.daps.dla.mil>.

3. DSCC - Defense Supply Center Columbus; (See FS).
 4. FED-STD - Federal Standard; (See FS).
 5. FS - Federal Specification; Available from Department of Defense Single Stock Point; <http://dodssp.daps.dla.mil>.
 - a. Available from Defense Standardization Program; www.dsp.dla.mil.
 - b. Available from General Services Administration; www.gsa.gov.
 - c. Available from National Institute of Building Sciences/Whole Building Design Guide; www.wbdg.org/ccb.
 6. USAB - United States Access Board; www.access-board.gov.
 7. USATBCB - U.S. Architectural & Transportation Barriers Compliance Board; (See USAB).
- F. State Government Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. This information is subject to change and is believed to be accurate as of the date of the Contract Documents.
1. CBHF; State of California; Department of Consumer Affairs; Bureau of Electronic Appliance and Repair, Home Furnishings and Thermal Insulation; www.bearhfti.ca.gov.
 2. CCR; California Code of Regulations; Office of Administrative Law; California Title 24 Energy Code; www.calregs.com.
 3. CDHS; California Department of Health Services; (See CDPH).
 4. CDPH; California Department of Public Health; Indoor Air Quality Program; www.cal-iaq.org.
 5. CPUC; California Public Utilities Commission; www.cpuc.ca.gov.
 6. SCAQMD; South Coast Air Quality Management District; www.aqmd.gov.
 7. TFS; Texas Forest Service; Forest Resource Development and Sustainable Forestry; <http://txforestservation.tamu.edu>.

PART 2 - PRODUCTS

Not Used.

PART 3 - EXECUTION

Not Used.

END OF SECTION 01 42 00

SECTION 01 51 00
TEMPORARY UTILITIES

PART 1 - GENERAL

1.01 SUMMARY

- A. Furnish, install, maintain, and protect temporary utilities required for construction of the Buildings at locations and in a manner that will be safe, non-hazardous, sanitary, and protective of persons and property, and free of deleterious effects.
- B. Remove physical evidence of temporary utilities at completion of Work.

1.02 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with rules and recommendations of franchised utility companies and governing regulations.

PART 2 - PRODUCTS

2.01 MATERIALS, GENERAL

- A. Materials may be new or used, but shall be adequate in capacity for required usage, shall not create unsafe conditions, and shall not violate requirements of applicable codes and standards.

2.02 TEMPORARY UTILITIES

- A. Types of services required include, but not by way of limitation, surface drainage, electrical power and lighting, heating, ventilation, and telephone.
- B. Include temporary toilets, wash facilities and drinking water fixtures. Comply with regulations and health codes for the type, number, location, operation and maintenance of fixtures and facilities. Install where facilities will best service the Project's needs.
 - 1. Provide drinking water units supplied with bottled water.
 - 2. Provide toilet tissue, paper towels, paper cups and similar disposable materials for each facility. Provide covered waste containers for used material.
- C. Comply with utility company's recommendations on materials and methods, or engage utility companies to install services.
- D. Water Used for Construction:
 - 1. Provide potable water adequate for construction.
 - 2. Where non-potable water is used, mark each outlet with adequate health-hazard warning signs.
- E. Arrange with electric company and provide service required for power. Provide connections and pay costs of installation, maintenance, operation, removal of service, and

power used.

F. Electrical Power:

1. Provide weatherproof, grounded, power distribution system sufficient to accommodate construction operations requiring power, use of power tools, electrical heating, lighting, and start-up testing of permanent electric-powered equipment system.
2. Provide overload protection, disconnect switches, and other required electrical devices.

G. Lighting:

1. Provide sufficient temporary lighting for proper workmanship; by combined use of daylight, general lighting, and portable plug-in task lighting.
2. Provide general lighting with local switching which will enable energy conservation during periods of varying activity.

H. Heating and Ventilating:

1. Prior to enclosure, provide heating as necessary to protect work, materials, and equipment against damage from dampness and cold.
2. Provide temporary heat and ventilation as areas are closed-in as necessary to maintain minimum temperature of 55 degrees F (except where higher temperatures are specified in various Technical Special Provision Sections), to facilitate progress of work, to meet specified minimum conditions for installation of materials, and to protect materials and finishes from damage due to temperature or humidity.
3. Provide adequate forced ventilation of enclosed areas for curing of installed materials, to disperse humidity, and to prevent hazardous accumulations of dust, fumes, vapors, or gases.
4. Solid fuel salamanders will not be permitted.
5. Provide connections to existing facilities, where occurring, extent and supplement with temporary units as required to comply with requirements.

2.03 FIRE PROTECTION

- A. During construction, provide temporary fire protection in accordance with local Fire Protection Code, governing authorities, and NFPA 10 - Portable Fire Extinguishers.
- B. Provide fire extinguishers of types, sizes, numbers, and locations as would be reasonably effective in extinguishing fires during early stages.
- C. Take necessary precautions in welding or cutting operations to keep work area free of combustible material.

- D. Do not use welding equipment around flammable liquids or vapors.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Review site conditions and factors which affect construction procedures and construction facilities, including adjacent properties and public facilities, which may be affected by execution of Work.

3.02 INSTALLATION

- A. Establish and initiate use of each temporary facility at time first reasonably required for proper performance of the Work.
- B. Locate temporary support facilities for convenience of users, and for minimum interference with construction activities. Maintain and operate systems continuously during entire construction period. Modify and extend systems as work progress requires.
- C. Install facilities of neat and reasonable uniform appearance, structurally adequate for required purposes.
- D. Terminate use and remove facilities at earliest reasonable time, when no longer needed or when permanent facilities have, with authorized use, replaced need. Discontinue and remove temporary facilities, and make incidental similar use of permanent work of project, only when and in manner authorized by Engineer and, if not otherwise indicated, immediately before time of Final Acceptance.

3.03 ENERGY CONSERVATION

- A. Install and operate temporary facilities and perform construction activities in manner which reasonably will be conservative and avoid waste of energy and materials including water.

3.04 RESTORATION AND REPLACEMENT

- A. Restore existing facilities used for temporary services to be specified or to original condition.
- B. Use filter in air conditioning units that are operated during construction, maintain filters as necessary, and replace filters upon completion of job.
- C. Replace burned out lamps used in permanent fixtures during construction with new lamps.

3.05 CLEANING AND REPAIR

- A. Clean and repair damage caused by installation or by use of temporary facilities.
- B. Grade area of site affected by temporary installations to required elevations and slopes.

END OF SECTION 01 51 00

SECTION 01 74 23
FINAL CLEANING

PART 1 - GENERAL

1.01 SUMMARY

A. Provide Final Cleaning as follows:

1. Provide Final Cleaning of the Work, immediately prior to Final Acceptance, consisting of cleaning each surface or unit of Work to normal "clean" condition expected for a first-class building cleaning and maintenance program. Comply with manufacturer's written instructions for cleaning operations.
2. The following are examples, but not by way of limitation, of cleaning levels required:
 - a. Remove labels which are not required as permanent labels, including all gum residue.
 - b. Clean exposed exterior and interior hard-surface finishes, to a dirt-free condition, free of dust, stains, films and similar noticeable distracting substances. Except as otherwise indicated, avoid disturbance of natural weathering of exterior surfaces. Restore reflective surfaces to original reflective condition. Buff out scratches and marks on exposed metal surfaces.
 - c. Wipe surfaces of mechanical and electrical equipment clean; remove excess lubrication and other substances.
 - d. Remove debris and surface dust from limited-access spaces including roofs and similar spaces. Clean tops of ductwork and horizontal surfaces of structural members in exposed areas.
 - e. Clean concrete floors in non-occupied spaces. Remove noticeable paint marks and construction stains.
 - f. Clean light fixtures and lamps so as to function at full efficiency. Replace any damaged lens.

B. Provide final cleaning of the Site as follows:

1. Provide Final Cleaning of the Work, immediately prior to Final Acceptance expected for a first-class building cleaning and maintenance program.
2. The following are examples, but not by way of limitation, of cleaning levels required:
 - a. Clean areas in accordance with Paragraph A. above for building areas affected by the Contractor for work performed after the Final Acceptance.
 - b. Clean Project Site, of litter and foreign substances. Sweep paved areas to

a broom-clean condition; remove stains, petrochemical spills and other foreign deposits. Rake grounds that are neither planted nor paved, to a smooth, even-textured surface, breaking up or removing clumps of material.

1.02 RELATED WORK

A. PROJECT CLOSEOUT: Section 01 77 00.

PART 2 - PRODUCTS

"Not Used"

PART 3 - PART 3 - EXECUTION

"Not Used"

END OF SECTION 01 74 23

SECTION 01 77 00
PROJECT CLOSEOUT

PART 1 - GENERAL

1.01 SUMMARY

- A. This Technical Special Provision specifies general administrative and procedural requirements for project closeout. The requirements include, but are not limited to, the following:
1. Functional Building Acceptance and Final Acceptance inspection procedures.
 2. Project Record Document submittals.
 3. Operating instructions and maintenance manual submittals.
 4. Submittal of warranties, guarantees, and maintenance agreements.
 5. Final cleaning.

1.02 FUNCTIONAL BUILDING ACCEPTANCE

- A. Prior to a request for an inspection for Functional Building Acceptance, maintain the following procedures:
1. Conduct walk-through inspections in the presence of the Engineer in the month prior to the request for Functional Building Acceptance. Each inspection shall determine outstanding work necessary to meet the Functional Building Acceptance requirements stipulation under this Technical Special Provision.
 2. A list of outstanding work required will be updated by the Engineer with the Contractor. The outstanding work list will be reduced progressively from the initial inspection until, in the opinion of the Engineer, the Contractor's work qualifies as to the state of readiness for the formal inspection punch-list prior to Functional Building Acceptance by the Owner.
- B. Functional Building Acceptance shall require that the following be accomplished:
1. The stage of completeness that constitutes the state of Functional Building Acceptance is based on the essential completion of the Contract requirements including, but not limited to, the following:
 - a. All civil, structural, architectural, mechanical, plumbing, and electrical work is complete for use as determined by the Engineer and/or Owner.
 - b. Letter from the Contractor stating that all code violations have been corrected along with copies of Final Inspection Reports representing each discipline to the Building Inspection/ Permitting Agency.
 - c. All mechanical, electrical, security, and fire alarm systems have been made operational and tested under the direct supervision of the

manufacturer's qualified factory representative, in the presence of the accepting authority having jurisdiction over the Work.

- (1) The manufacturers have issued a certified letter of compliance and satisfactory operation to the Engineer.
 - (2) The manufacturers have provided the required operation training, for the purpose of aiding the Owner's maintenance and operations personnel to become familiar with the systems.
 - d. Turn over all releases enabling the Owner unrestricted use of the Work and access to services and utilities.
 - e. Complete clean up requirements, including touch-up painting. Touch-up and otherwise repair and restore marred exposed finishes.
 - f. Provide the Engineer with the following list of approvals and certifications:
 - (1) Letter of approval from the Building Inspection/ Permitting Agency inspector.
 - (2) Fire alarm test certification by the Fire Marshal.
 2. Upon the confirmation that the above requirements have been satisfied, request the Engineer to schedule an inspection for Functional Building Acceptance.
 3. Provide the Engineer with a list of all items needed from the Engineer to request a Certificate of Occupancy for the facilities constructed for this project. These items may include, but are not limited to, the following:
 - a. Certification that the structure meets or exceeds the flood plain criteria defined in the FEMA document 44 CFR - Part 60.
 - b. Certification of compliance to the Owner of Environmental Regulation Management Pollution Control.
 4. After these items are provided, the Contractor may apply to the Building Inspection/Permitting Agency for a Certificate of Occupancy for the facilities constructed by this project. Upon receipt of the Certificate of Occupancy, provide the following:
 - a. Insurance change-over.
 - b. Make final change-over of permanent locks and transmit keys to the Engineer. Advise the Engineer of change-over in security provisions.
- C. After the Contractor receives the Certificate of Occupancy, the Owner will make a declaration of Functional Building Acceptance covering only that portion of the Project subject to Functional Building Acceptance, will occupy the new facilities, and will have two (2) weeks to list any deficiencies not apparent during the inspection for Functional

Building Acceptance.

- D. Functional Building Acceptance shall continue until Final Acceptance.

1.03 FINAL ACCEPTANCE

- A. Prior to a request for an inspection for Final Acceptance, maintain the following procedures:
 - 1. Conduct walk-through inspections in the presence of the Engineer in the month prior to the request for Final Acceptance. Each inspection shall determine outstanding work necessary to meet the Final Acceptance requirements stipulation under this Technical Special Provision. A list of outstanding work required will be updated by the Engineer with the Contractor. The outstanding work list will be reduced progressively from the initial inspection until, in the opinion of the Engineer, the Contractor's work qualifies as to the state of readiness for the formal inspection punch-list prior to Final Acceptance by the Owner.
- B. Final Acceptance for the Project shall require that the following be accomplished:
 - 1. All record documents, maintenance manuals and equipment operational instructions have been turned over to the Owner's representatives and equipment operational demonstrations have been performed pursuant to Technical Special Provision: 01 78 39 – RECORD DOCUMENTS, MAINTENANCE MANUALS, EQUIPMENT OPERATIONAL INSTRUCTIONS/ DEMONSTRATIONS.
 - 2. All punch list items completed and accepted.
 - 3. Certification that construction meets the requirements of the Water Management District permit.
 - 4. Remove temporary facilities from the site, along with construction tools and equipment, mock-ups, and similar elements.
 - 5. Turn over Warranties, Guarantees, Workmanship Bonds, Maintenance Agreements, Final Certifications, and similar closeout documents on various materials, systems and equipment, neatly bound and in order to the Engineer.
 - 6. Turn over extra stock as specified in other Technical Special Provisions to the person designated by the Engineer to be in charge of the operation and maintenance of the building(s).
 - 7. Provide instruction to Owner in maintenance of equipment and finishes.
 - 8. Turn over special tools for items such as louver vanes, adjustable dampers, thermostats, allen-head locking devices, to the person designated by the Owner, to be in charge of the operation and maintenance of the building, as required by applicable Technical Special Provisions.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 01 77 00

SECTION 01 78 36
GUARANTEES/WARRANTIES/REPAIRS

PART 1 - GENERAL

1.01 SUMMARY

- A. This Technical Special Provision specifies general administrative and procedural requirements for guarantees, warranties, and related repairs (or replacement) required by the Contract Documents, including manufacturer's standard warranties on products and special warranties.
- B. Disclaimers and Limitations: Manufacturer's disclaimers and limitations on product warranties do not relieve the Contractor of responsibilities in performance of the Work.

1.02 RELATED WORK

- A. PROJECT CLOSEOUT: Section 01 77 00.
- B. RECORD DOCUMENTS, MAINTENANCE MANUALS, AND EQUIPMENT OPERATIONAL INSTRUCTIONS/DEMONSTRATIONS: Section 01 78 39.
- C. Specific requirements for warranties for the Work and products and installations that are specified to be warranted are included in other Technical Special Provisions.
- D. Certifications and other commitments and agreements for continuing services to the Owner are specified elsewhere in the Technical Special Provisions.

1.03 MANUFACTURER AND SUPPLIER WARRANTIES

- A. All manufacturer and equipment supplier warranties shall commence on the Date of Final Acceptance of the total Contract as acknowledged in writing by the Owner and taken over for use by the Owner.
 - 1. Security, HVAC, Telephone/Intercom, Radio, and Standby Power Systems will not be accepted nor the initiation of warranty start recognized until these systems are functioning properly and acknowledged as accepted in writing by the Owner.
- B. Written warranties made to the Owner are in addition to implied warranties, and shall not limit duties, obligations, rights, and remedies otherwise available under the law, nor shall warranty periods be interpreted as limitations on time in which the Owner can enforce such other duties, obligations, rights, or remedies.
 - 1. Ensure that all warranties comply with these stipulations prior to submission.
- C. Repairs: All repairs or replacements resulting from a breach of warranty shall be promptly performed.

1.04 SUBMITTALS

- A. Submit written warranties to the Owner prior to the Date of Final Acceptance. If the Owner

designates a commencement date for warranties other than the Date of Final Acceptance, or a designated portion of the Work, submit written warranties on the Owner's request.

- B. Warranties shall be submitted properly executed by the supplier or manufacturer, or a combination thereof, as stipulated in other Technical Special Provisions. Warranties shall also be fully identified and contain all appropriate terms and conditions.
- C. Provide a bound manual for all manufacturer and equipment supplier warranties required by the Contract Documents. Identify each warranty with proper Technical Special Provision Section.

PART 2 - PRODUCTS

"Not Used"

PART 3 - EXECUTION

"Not Used"

END OF SECTION 01 78 36

SECTION 01 78 39
RECORD DOCUMENTS, MAINTENANCE MANUALS AND
EQUIPMENT OPERATIONAL INSTRUCTIONS/DEMONSTRATIONS

PART 1 - GENERAL

1.01 SUMMARY

- A. Provide Record Documents, Maintenance Manuals, and Equipment Operational Instructions/Demonstrations as follows:
 - 1. The provisions of this Technical Special Provision apply to the maintaining, marking, recording and submitting of Project Record Documents; organizing operating and maintenance data into suitable sets of manuals; and conducting operational instructions and demonstrations for each and every piece of equipment or system furnished under this Contract.
 - 2. Do not use record documents for construction purposes, protect from deterioration and loss in a secure, fire-resistive location. Provide access to record documents for the Engineer's reference during normal working hours.

1.02 RELATED WORK

- A. PROJECT CLOSEOUT: Section 01 77 00.
- B. GUARANTEES/WARRANTIES/REPAIRS: Section 01 78 36.

1.03 SUBMITTALS

- A. Record Documents: At completion of all Work under this Contract, deliver record documents to the Engineer, in duplicate with transmittal, containing as a minimum, the following:
 - 1. Date.
 - 2. Project title and numbers.
 - 3. Contractor's name and address. Include final list of all subcontractors.
 - 4. Title and number of each record document.
 - 5. Certification that each document as submitted is complete and accurate.
 - 6. Contractor's signature, or that of his authorized representative.
- B. Operating Instructions and Maintenance Manuals:
 - 1. Submit three (3) copies of each completed manual on equipment and systems, in final form, to the Engineer for distribution. Provide separate manuals for each unit of equipment, each operating system, and each electric and electronic system.
 - 2. Refer to Technical Special Provision Sections for individual requirements on

operating and maintenance of the various pieces of equipment and operating systems.

1.04 RECORD DOCUMENTS

A. Record Drawings:

1. Maintain a clean, undamaged, updated set of blue or black line white-prints of Plans, including sheets issued as part of Department authorized changes, and Shop Drawings. The set shall be marked to scale by a competent draftsman to indicated the actual installation and/or location where the installation and/or location varies substantially from the Work as originally shown due to Addenda, Alternates, Change Orders, Field Orders, etc.
2. Mark whichever Plans are most capable of showing conditions fully and accurately. Where shop drawings are used, record a cross-reference at the corresponding location on the Plans.
3. Use a red erasable pencil; use other colors to distinguish between variations in separate categories of the Work.
4. Give particular attention to concealed elements that would be difficult to measure and record at a later date.
5. Note related Change Order numbers where applicable.
6. Do not revise the prints by attaching the actual sketches issued by the Engineer. Where the work was installed exactly as shown on the Plans, the prints shall not be disturbed other than being marked "PROJECT RECORD DOCUMENTS".
7. Each sheet shall be clearly marked "PROJECT RECORD DOCUMENTS".
8. Organize record drawing sheets into manageable sets by discipline, bind with durable paper cover sheets, and print suitable titles, dates and other identification on the cover of each set.
9. Review the completed Project Record Drawings and ascertain that all data furnished on the prints is accurate and truly represents the work as actually installed.
10. The record drawing prints, including those changed and unchanged, shall be submitted to the Engineer for compliance review.
11. Any deviations from the method of executing Project Record Drawings as described above will be considered just cause for rejection by the Engineer and the Contractor will be required to conform and resubmit.
12. The record drawings shall be current with each month's pay estimate application, and subject to the Engineer's review for acceptability, as a prerequisite to monthly payment.

B. Record Project Manual/Technical Special Provision:

1. Maintain one complete copy of the Project Manual, including all addenda, and one copy of other written construction documents such as Change Orders and Modifications issued in printed form during construction. Mark these documents to show substantial variations in actual Work performed in comparison to the text of the Technical Special Provisions and modifications due to Addenda, Alternates, Change Orders, Field Orders, etc.
2. Neatly cross out the non-conforming portion of the Project Manual and add by writing in the revised portion of the Project Manual. Do not revise the Project Manual by "cutting and pasting" the actual Addenda, Alternates, Change Orders, Field Orders, etc., as actually issued by the Engineer unless otherwise directed by the Engineer.
3. Give particular attention to substitutions, selection of options and similar information on elements that are concealed or cannot otherwise be readily discerned later by direct observation. Note related Record Drawing information and Product Data.
4. The Volume(s) of Project Manual shall be clearly marked "PROJECT RECORD DOCUMENTS".
5. Review the completed Record Project Manual and ascertain that all data furnished on the Project Manual is accurate and truly represents the work as actually installed.
6. Submit the Record Project Manual to the Engineer for compliance review.
7. Any deviations from the method of executing Record Project Manual as described above will be considered just cause for rejection by the Engineer and the Contractor will be required to conform and resubmit.
8. The Record Project Manual shall be current with each month's pay estimate application, and subject to the Engineer's review for acceptability.

C. Record Product Data:

1. Maintain one copy of each Product Data submittal. Mark these documents to show significant variations in actual Work performed in comparison with information submitted. Include variations in products delivered to the site, and from the manufacturer's installation instructions and recommendations.
2. Give particular attention to concealed products and portions of the Work that cannot otherwise be readily discerned later by direct observation. Note related Change Orders and mark-up of record Drawings and Project Manual.
3. Upon completion of mark-up, submit complete set of record Product Data to the Engineer for the Department's records.

D. Record Samples:

1. Immediately prior to the date(s) of Final Acceptance, meet at the site(s) with the Engineer and the Department's personnel to determine which of the submitted Samples that have been maintained during progress of the Work are to be transmitted to the Department for record purposes. Comply with delivery to the Department's sample storage area.

E. Miscellaneous Record Submittals:

1. Miscellaneous record submittals shall include, but not be limited to, the following:
 - a. Warranties.
 - b. Inspection and test reports.
 - c. Field records.
 - d. Surveys.
 - e. Mix records.
 - f. Inspections by governing authorities.
2. Refer to individual Technical Special Provision sections for requirements of miscellaneous record-keeping and submittals in connection with actual performance of the Work.
3. Immediately prior to date(s) of Final Acceptance, complete miscellaneous records and place in good order, properly identified and bound or filed, ready for continued use and reference. Submit to the Engineer for the Department's records.

1.05 OPERATING INSTRUCTIONS AND MAINTENANCE MANUALS

- A. Submit complete operating instructions and maintenance manuals for each and every piece of equipment or system furnished under the Contract. Organize operating and maintenance data into suitable sets of manageable size. Bind properly indexed data in individual heavy-duty 2-inch, 3-ring vinyl-covered binders, with pocket folders for folded sheet information. Mark appropriate identification on front and spine of each binder.
- B. Equipment and Systems: Provide the following information for each piece of equipment, each building operating systems, and each electric or electronic system.
 1. 1. Description: Provide a complete description of each unit and related component parts, including the following:
 - a. Equipment or system function.
 - b. Operating characteristics.
 - c. Limiting conditions.
 - d. Performance curves.

- e. Engineering data and tests.
 - f. Complete nomenclature and number of replacement parts.
 - g. Copies of warranties.
 - h. Copies of inspection and test reports.
 - i. Wiring diagrams.
 - j. Recommended "turn around" cycles.
 - k. Inspection procedures.
 - l. Shop Drawings and Product Data.
 - m. Fixture lamping schedule.
2. Manufacturer's Information: For each manufacturer of a component part of piece of equipment provide the following:
- a. Printed operating and maintenance instructions.
 - b. Assembly drawings and diagrams required for maintenance.
 - c. List of items recommended to be stocked as spare parts.
3. Maintenance Procedures: Provide information detailing essential maintenance procedures, including the following:
- a. Routine operations.
 - b. Trouble-shooting guide.
 - c. Disassembly, repair and reassembly.
 - d. Alignment, adjusting and checking.
4. Operating Procedures: Provide information on equipment and system operating procedures, including the following:
- a. Start-up procedures.
 - b. Equipment or system break-in.
 - c. Routine and normal operating instructions.
 - d. Regulation and control procedures.
 - e. Instructions on stopping.
 - f. Shut-down and emergency instructions.

- g. Summer and winter operating instructions.
 - h. Required sequences for electric or electronic systems.
 - i. Special operating instructions.
5. Servicing Schedule: Provide a schedule of routine servicing and lubrication requirements, including a list of required lubricants for equipment with moving parts.
 6. Controls: Provide a description of the sequence of operation and as-installed control diagrams by the control manufacturer for systems requiring controls.
 7. Coordination Drawings: Provide each Contractor's Coordination Drawings.
 - a. Provide as-installed color-coded piping diagrams, where required for identification.
 8. Valve Tags: Provide charts of valve tag numbers, with the location and function of each valve.
 9. Circuit Directories: For electric and electronic systems, provide complete circuit directors of panelboards, including the following:
 - a. Electric service.
 - b. Controls.
 - c. Communication.

PART 2 - PRODUCTS

"Not Used"

PART 3 - PART 3 - EXECUTION

3.01 EQUIPMENT OPERATIONAL DEMONSTRATIONS

- A. Prior to Final Acceptance of the whole Work or designated portions thereof, provide a competent and experienced person (or persons) thoroughly familiar with the Work to demonstrate to, and instruct the Department's personnel in operation, adjustment and maintenance of products, equipment and systems.
- B. This instruction shall include normal start-up, run, stop, and emergency operations, location and operation of all controls, alarms and alarm systems, etc. The instruction shall include tracing the system in the field and on the diagrams in the instruction booklets so that the Department's operating personnel will be thoroughly familiar with both the system and the data supplied. Provide instruction at mutually agreed upon times.
 1. Use operation and maintenance manuals for each piece of equipment or system as the basis of instruction. Review contents in detail to explain all aspects of

operation and maintenance.

2. For equipment that requires seasonal operation, provide similar instruction during other seasons.

C. If installers and/or Contractor's personnel are not experienced in operational procedures, provide instruction by manufacturer's representatives. Include a detailed review of the following: (Items listed are examples only and not all inclusive)

1. Maintenance manuals.
2. Record documents.
3. Spare parts and materials.
4. Tools.
5. Lubricants.
6. Fuels.
7. Identification systems.
8. Control sequences.
9. Hazards.
10. Cleaning.
11. Warranties and bonds.
12. Maintenance agreements and similar continuing commitments.
13. Similar procedures and facilities.

D. As part of instruction for operating equipment, demonstrate the following procedures: (Items listed are examples only and not all inclusive)

1. Start-up.
2. Shut down.
3. Emergency operations.
4. Noise and vibration adjustments.
5. Safety procedures.
6. Economy and efficiency adjustments.
7. Effective energy utilization.

8. Similar operations.
 - E. Review maintenance and operations in relation with applicable warranties, agreements to maintain, bonds, and similar continuing commitments.
 - F. Engineer shall be notified in writing of scheduling and completion of all equipment operational instructions and demonstrations with Department's personnel.

END OF SECTION 01 78 39

SECTION 01 79 00
DEMONSTRATION AND TRAINING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section includes administrative and procedural requirements for instructing Owner's personnel, including the following:
 - 1. Demonstration of operation of systems, subsystems, and equipment.
 - 2. Training in operation and maintenance of systems, subsystems, and equipment.
- B. Related Requirements:
 - 1. Divisions 02 through 41 Sections for specific requirements for demonstration and training for products in those Sections.

1.03 INFORMATIONAL SUBMITTALS

- A. Instruction Program: Submit outline of instructional program for demonstration and training, including a list of training modules and a schedule of proposed dates, times, length of instruction time, and instructors' names for each training module. Include learning objectives and outline for each training module.
- B. Qualification Data: For facilitator, instructor.
- C. Attendance Record: For each training module, submit list of participants and length of instruction time.
- D. Evaluations: For each participant and for each training module, submit results and documentation of performance-based tests.

1.04 QUALITY ASSURANCE

- A. Facilitator Qualifications: A firm or individual experienced in training or educating maintenance personnel in a training program similar in content and extent to that indicated for this Project, and whose work has resulted in training or education with a record of successful learning performance.
- B. Preconstruction Conference: Conduct conference at Project site review methods and procedures related to demonstration and training including, but not limited to, the following:
 - 1. Inspect and discuss locations and other facilities required for instruction.

2. Review and finalize instruction schedule and verify availability of educational materials, instructors' personnel, audiovisual equipment, and facilities needed to avoid delays.
3. Review required content of instruction.
4. For instruction that must occur outside, review weather and forecasted weather conditions and procedures to follow if conditions are unfavorable.

1.05 COORDINATION

- A. Coordinate instruction schedule with Owner's operations. Adjust schedule as required to minimize disrupting Owner's operations and to ensure availability of Owner's personnel.
- B. Coordinate instructors, including providing notification of dates, times, length of instruction time, and course content.
- C. Coordinate content of training modules with content of approved emergency, operation, and maintenance manuals. Do not submit instruction program until operation and maintenance data has been reviewed and approved by Architect.

PART 2 - PRODUCTS

2.01 INSTRUCTION PROGRAM

- A. Individual Specification Sections include requirements for demonstration and training. Architect may elect to furnish report to Contractor listing applicable Sections and requirements to facilitate development of instruction program; see Evaluations.
- B. Training Modules: Develop a learning objective and teaching outline for each module. Include a description of specific skills and knowledge that participant is expected to master. For each module, include instruction for the following as applicable to the system, equipment, or component:
 1. Basis of System Design, Operational Requirements, and Criteria: Include the following:
 - a. System, subsystem, and equipment descriptions.
 - b. Performance and design criteria if Contractor is delegated design responsibility.
 - c. Operating standards.
 - d. Regulatory requirements.
 - e. Equipment function.
 - f. Operating characteristics.
 - g. Limiting conditions.

- h. Performance curves.
2. Documentation: Review the following items in detail:
- a. Emergency manuals.
 - b. Operations manuals.
 - c. Maintenance manuals.
 - d. Project record documents.
 - e. Identification systems.
 - f. Warranties and bonds.
 - g. Maintenance service agreements and similar continuing commitments.
3. Emergencies: Include the following, as applicable:
- a. Instructions on meaning of warnings, trouble indications, and error messages.
 - b. Instructions on stopping.
 - c. Shutdown instructions for each type of emergency.
 - d. Operating instructions for conditions outside of normal operating limits.
 - e. Sequences for electric or electronic systems.
 - f. Special operating instructions and procedures.
4. Operations: Include the following, as applicable:
- a. Startup procedures.
 - b. Equipment or system break-in procedures.
 - c. Routine and normal operating instructions.
 - d. Regulation and control procedures.
 - e. Control sequences.
 - f. Safety procedures.
 - g. Instructions on stopping.
 - h. Normal shutdown instructions.
 - i. Operating procedures for emergencies.

- j. Operating procedures for system, subsystem, or equipment failure.
 - k. Seasonal and weekend operating instructions.
 - l. Required sequences for electric or electronic systems.
 - m. Special operating instructions and procedures.
 - n. Noise and vibration adjustments.
 - o. Economy and efficiency adjustments.
 - p. Effective energy utilization.
5. Adjustments: Include the following:
- a. Alignments.
 - b. Checking adjustments.
 - c. Noise and vibration adjustments.
 - d. Economy and efficiency adjustments.
6. Troubleshooting: Include the following:
- a. Diagnostic instructions.
 - b. Test and inspection procedures.
7. Maintenance: Include the following:
- a. Inspection procedures.
 - b. Types of cleaning agents to be used and methods of cleaning.
 - c. List of cleaning agents and methods of cleaning detrimental to product.
 - d. Procedures for routine cleaning
 - e. Procedures for preventive maintenance.
 - f. Procedures for routine maintenance.
 - g. Instruction on use of special tools.
8. Repairs: Include the following:
- a. Diagnosis instructions.
 - b. Repair instructions.

- c. Disassembly; component removal, repair, and replacement; and reassembly instructions.
- d. Instructions for identifying parts and components.
- e. Review of spare parts needed for operation and maintenance.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Assemble educational materials necessary for instruction, including documentation and training module. Assemble training modules into a training manual organized in coordination with requirements in Section 01 78 39 "Record Doc, Maint Manuals & Equip Oper Instr-Demo."
- B. Set up instructional equipment at instruction location.

3.02 INSTRUCTION

- A. Facilitator: Engage a qualified facilitator to prepare instruction program and training modules, to coordinate instructors, and to coordinate between Contractor and Owner for number of participants, instruction times, and location.
- B. Provide manufacturer's instructors or instructors certified by manufacturer as being experienced in operation and maintenance procedures for each system, subsystem, or piece of equipment to instruct Owner's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.
 - 1. Architect will furnish an instructor to describe basis of system design, operational requirements, criteria, and regulatory requirements.
 - 2. Owner will furnish an instructor to describe Owner's operational philosophy.
 - 3. Owner will furnish Contractor with names and positions of participants.
- C. Scheduling: Provide instruction at mutually agreed on times. For equipment that requires seasonal operation, provide similar instruction at start of each season.
 - 1. Schedule training with Owner, through Construction Manager, with at least seven days' advance notice.
 - 2. Schedule training to conform to personnel availability at Site and to conclude prior to start-up of system.
- D. Training Location and Reference Material: Conduct training on-site in the completed and fully operational facility using the actual equipment in-place. Conduct training using final operation and maintenance data submittals.
- E. Evaluation: At conclusion of each training module, assess and document each participant's mastery of module by use of a demonstration performance-based test.

- F. In addition to written technical descriptions, training shall detail training program to allow those who have completed training to provide training for new employees resulting in self-perpetuating training program.
- G. Cleanup: Collect used and leftover educational materials and give to Owner. Remove instructional equipment. Restore systems and equipment to condition existing before initial training use.

END OF SECTION 01 79 00

SECTION 03 10 00
CONCRETE FORMING AND ACCESSORIES (SITE)

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Furnish all labor, materials, equipment, tools and services required to fully complete all Concrete Forming work as required by the Drawings and/or specified herein including, but not limited to, the following described items.
- B. Formwork for cast-in place building concrete, with shoring, bracing and anchorage.
- C. Form Stripping.

1.02 RELATED REQUIREMENTS

- A. Section 01 11 00 – Summary of Work
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) Requirements
- B. Section 03 15 11 - Concrete Anchors
- C. Section 03 20 00 – Reinforcing
- D. Section 03 30 00 – Cast-In-Place Concrete

1.03 SUBMITTALS

- A. See Section 01 33 00 – Submittal Procedures, for submittal procedures.
- B. Shop Drawings: Indicate pertinent dimensions, materials, bracing, and arrangement of joints and ties.
 - 1. Pertinent dimensions, openings, methods of construction, types of connections, materials, joint arrangement and details, ties and shores, location of framing, studding and bracing, and temporary supports.
 - 2. Means of leakage prevention for concrete exposed to view in finished construction.
 - 3. Sequence and timing of erection and stripping, assumed compressive strength at time of stripping, height of lift and height of drop during placement.
 - 4. Vertical, horizontal, and special loads in accordance with ACI 347, Section 2.2 and camber diagrams, when applicable.
 - 5. Notes to formwork erector showing size and location of conduits and piping embedded in concrete in accordance with ACI 318, Section 6.3.
- C. Design Data: As required by authorities having jurisdiction.

1. Pertinent dimensions, openings, methods of construction, types of connections, materials, joint arrangement and details, ties and shores, location of framing, studding and bracing, and temporary supports.
2. Means of leakage prevention for concrete exposed to view in finished construction.
3. Sequence and timing of erection and stripping, assumed compressive strength at time of stripping, height of lift and height of drop during placement.
4. Vertical, horizontal, and special loads in accordance with ACI 347, Section 2.2 and camber diagrams, when applicable.
5. Notes to formwork erector showing size and location of conduits and piping embedded in concrete in accordance with ACI 318, Section 6.3.

1.04 QUALITY ASSURANCE

- A. Maintain one copy of each installation standard on site throughout the duration of concrete work.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. All form materials and accessories shall be stored above ground on framework or blocking and shall be covered with a suitable waterproof covering providing adequate air circulation and ventilation.

PART 2 - PRODUCTS

2.01 FORMWORK- GENERAL

- A. Formwork Standards: Unless otherwise indicated, design, construct, erect, maintain, and remove forms and related structures for concrete work in accordance with applicable requirements of ACI 301, ACI 318, and ACI 347.
 1. Deflection: Where dead and live loads on forms will be more than 20 percent greater than the weight of the concrete, provide framing lumber of required strength, and comply with ACI 301 and ACI 347 for design of framing members. Deflection shall be kept within the herein specified tolerances.
 2. Concrete Mix Design: Design of formwork shall be coordinated with the concrete mix design, as specified in Section 03 30 00 – Cast-In-Place Concrete, so that form materials, form surfaces, and formwork strength will produce the desired concrete tolerances and finished.
- B. Formwork Surface Materials: Provide material and work quality which will produce clean, smooth, and uniform finished surfaces within the allowable tolerances specified and which will conform with the following requirements:
 1. Concrete Exposed to View: Provide material and work quality that will produce clean, smooth, and uniform concrete surfaces. Transfer of wood grain to concrete is not acceptable. Refer to Section 03 30 00 – Cast-In-Place Concrete and ACI 301

for requirements.

2. Concrete Concealed from View: Provide material and work quality that will produce aligned concrete surfaces free of fins, honeycomb, and stains.
- C. Special Formwork Sections: Provide openings, offsets, sinkages, keyways, recessed, moldings, rustication strips, chamfers, blocking, screeds, bulkheads, anchorages, embedded items, and other features. Select materials and provide workmanship that will ensure indicated finishes.
- D. Provide concrete forms, accessories, shoring, and bracing as required to accomplish cast-in-place concrete work.
- E. Design and construct concrete that complies with design with respect to shape, lines, and dimensions.
- F. Chamfered Corners: All outside corners of beams, joists, columns, and walls shall be chamfered, unless otherwise indicated.
- G. Comply with applicable state and local codes with respect to design, fabrication, erection, and removal of formwork.
- H. Comply with relevant portions of ACI 301, ACI 318, and ACI 347R.
- I. Removal Features: Design formwork to be readily removable without impact, shock, and damage to concrete surfaces and adjacent materials.
- J. Tolerances for Formed Surfaces: For buildings and similar structures, comply with the requirements of ACI 301, as applicable. For those items of work or parts of the structure not covered by ACI 301, comply with the requirements of ACI 117, as applicable. Coordinate with the requirements specified in Section 03 30 00 – Cast-In-Place Concrete.

2.02 WOOD FORM MATERIALS

- A. Softwood Plywood Forms: Plywood shall be graded and grade-marked in accordance with U.S. Product Standard PS 1.
 1. B-B Plyform: Provide Class I, EXT-APA, sanded, APA trademarked.
 2. B-C Plyform: Provide Class I, EXT-APA, APA trademarked.
 3. High Density Overlay (HDO) Plyform: Provide A-A, 60-60, Class I, EXT-APA, APA trademarked.
 4. Thickness: As required to maintain surface smoothness without deflection, but not thinner than 5/8 inch (16 mm).
- B. Lumber Forms: Douglas Fir species; No. 2 grade; with stamp clearly visible.
 1. Boards: Use dressed side of lumber for surface in contact with the concrete, and provide boards with shiplapped or tongue and groove edges to prevent mortar leakage.

- C. Framing, Studding, and Bracing Lumber: Stud or No. 2 structural light framing grade.

2.03 REMOVABLE PREFABRICATED FORMS

A. Manufacturers:

1. Symons-Dayton Superior Corporation
2. Advance Concrete Form, Inc.
3. EFCO Corporation
4. Western Forms

- B. Preformed Steel Forms: Fabricated steel forms, using standard or commercial quality uncoated steel sheet or plate, 3-16 inch (5 mm) minimum thickness, for panel facings. Provide surfaces that will not impart corrosion residue to concrete. Include panel framing, reinforcement, and erection accessories.

2.04 FORMWORK ACCESSORIES

- A. Leakage Control Materials: Provide materials capable of producing flush, watertight, and non-absorbent surfaces and joints, and compatible with forming material and concrete ingredients. Seal form edges with gasketing material or sealant placed in the joint in such a way that neither a fin nor groove is made in the face of the cast concrete.

1. Caulking Compound: Silicone or polyurethane construction sealant conforming to ASTM C1184 or ASTM C920, as applicable.
2. Tapes: Form film tape or polypropylene plastic treated with waterproof adhesive, for joint conditions not exposed to view.

- B. Form Release Agent: Commercial formulation, designed for use on all types of forms, capable of releasing forms from hardened concrete without staining or discoloring concrete or forming bugholes and other surface defects, and not requiring removal for satisfactory bonding of coatings to be applied.

- C. Form Ties: Rod type, with ends of end fasteners which can be removed without spalling the concrete and which leave a hole equal in depth to the required reinforcement clearance. Form ties shall be of a design in which the hole left by the removed end or end fastener is easily filled to match the surface of the hardened concrete. Provide removable cones 1-1/4 inches (32 mm) in diameter by 1-1/2 inches (38 mm) deep. Provide preformed mortar plugs to match the color of the concrete, recessed 1/4 inch (6 mm), adhered with an approved epoxy adhesive.

- D. Inserts: Cast stainless steel or welded stainless steel, Type 316 or similar 300 Series, complete with anchors to concrete and fittings such as bolts, wedges, and straps. Provide hanger inserts where detailed.

- E. Filler Strips for Chamfered Corners: Rigid plastic or wood strip type; 3/4 x 3/4 inch size; maximum possible lengths.

- F. Flashing Reglets: Galvanized steel at least 22 gage, 0.0299 inch thick, longest possible lengths, with alignment splines for joints, foam filled, release tape sealed slots, anchors for securing to concrete formwork.
- G. Vapor Retarder: As specified in Section 03 30 00.
- H. Nails, Spikes, Lag Bolts. Through Bolts, Anchorages: Sized as required, of sufficient strength and character to maintain formwork in place while placing concrete.
- I. Embedded Anchor Shapes, Plates, Angles and Bars: As specified in Section 05 12 00.
- J. Waterstops: As specified in Section 03 30 00.
- K. Joint Filler: As specified in Section 07 92 00.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify lines, levels and centers before proceeding with formwork. Ensure that dimensions agree with drawings.

3.02 EARTH FORMS

- A. Earth forms are not permitted unless noted on the drawings.

3.03 ERECTION – FORMWORK

- A. Erect formwork, shoring and bracing to achieve design requirements, in accordance with requirements of ACI 301 and approved Shop Drawings, and in a manner that will produce finished concrete surfaces conforming to indicated design and within specified tolerances.
- B. Provide bracing to ensure stability of formwork. Shore or strengthen formwork subject to overstressing by construction loads. Support joints with extra studs or girts, and in a manner that will ensure true, square intersections.
- C. Brace temporary closures to prevent warpage or displacement and set tightly against forms in a manner that will prevent loss of concrete mortar.
- D. Kerf wood inserts for forming, keyways, reglets, and recesses in a manner that will prevent swelling and ensure ease of removal.
- E. Construct molding shapes, recesses, and projections with smooth finish materials and install forms with sealed joints.
- F. Maintain forms clean and free from indentations and warpage. Do not use rust-stained steel surfaces for forms in contact with concrete. Do not sandblast steel form surfaces to remove rust or mill scale; remove these imperfections by grinding.
- G. Arrange and assemble formwork to permit dismantling and stripping. Do not damage concrete during stripping. Permit removal of remaining principal shores.

- H. Make joints and seams mortar-tight. Install leakage control materials in accordance with the manufacturer's installation instructions, and in a manner that will maintain a smooth continuity of plane between abutting form panels and which will resist displacement by concreting operations.
- I. Provide camber in formwork as required to compensate for deflections caused by weight and pressures of fresh concrete and construction loads and as otherwise indicated. Provide camber strips to compensate for deflections due to permanent loads and long-term deflections due to shrinkage and creep as required.
- J. Edge Forms and Screed for Slabs: Set edge forms or bulkheads and intermediate screeds for slabs to obtain required elevations and contours in the finished slab surface. Support screeds substantially without penetrating waterproof membranes and vapor barriers.
- K. Corner Treatment: Form chamfers with 3/4 inch (19 mm) on each leg, unless otherwise indicated, and accurately shape and surface in a manner which will produce uniformly straight lines and edge joints and which will prevent mortar runs. Extend terminal edges to limits, and miter chamfer strips at changes in direction.
- L. Construction Joints:
 - 1. Locate joints as indicated. Support forms for joints in concrete so as to rigidly maintain their positions during placement, vibration, and curing of concrete. Install keys in all joints.
 - 2. Locate and install construction joints, for which locations are not indicated, so as not to impair strength and appearance of structure and indicate such joints on Shop Drawings. Locations of construction joints will require approval of the Engineer.
 - 3. Position joints perpendicular to longitudinal axis of pier, beam or slab as the case may be.
 - 4. Locate joints in walls, vertically as indicated; at top of footing; at top of slabs on grade; at bottom of door openings; and at underside of the deepest beam or girder framing into wall; or as required to conform to indicated details.
 - 5. Provide keyways as indicated in construction joints in walls and slabs, and between walls and footings unless otherwise indicated. Place construction joints perpendicular to the main reinforcement. Continue reinforcement across construction joints.
- M. Obtain approval before framing openings in structural members that are not indicated on drawings.
- N. Coordinate this section with other sections of work that require attachment of components to formwork.
- O. If formwork is placed after reinforcement, resulting in insufficient concrete cover over reinforcement, request instructions from Architect before proceeding.

3.04 APPLICATION – FORM RELEASE AGENT

- A. Apply form release agent of formwork in accordance with manufacturer's recommendations.
- B. Apply prior to placement of reinforcing steel, anchoring devices, and embedded items.
- C. Do not apply form release agent where concrete surfaces will receive special finishes or applied coverings that are affected by agent. Soak inside surfaces of untreated forms with clean water. Keep surfaces coated prior to placement of concrete.

3.05 INSERTS, EMBEDDED PARTS, AND OPENINGS

- A. Provide formed openings where required for items to be embedded in passing through concrete work.
- B. Locate and set in place items that will be cast directly into concrete.
- C. Coordinate with work of other sections in forming and placing openings, slots, reglets, recesses, sleeves, bolts, anchors, other inserts, and components of other work.
- D. Install accessories in accordance with manufacturer's instructions, so they are straight, level, and plumb. Ensure items are not disturbed during concrete placement.
- E. Install waterstops in accordance with manufacturer's instructions, so they are continuous without displacing reinforcement. Heat seal joints so they are watertight.
- F. Provide temporary ports or openings in formwork where required to facilitate cleaning and inspection. Locate openings at bottom of forms to allow flushing water to drain.
- G. Close temporary openings with tight fitting panels, flush with inside face of forms, and neatly fitted so joints will not be apparent in exposed concrete surfaces.

3.06 FORM CLEANING AND RE-USE

- A. Clean forms as erection proceeds, to remove foreign matter within forms.
- B. Clean formed cavities of debris prior to placing concrete.
 - 1. Flush with water or use compressed air to remove remaining foreign matter. Ensure that water and debris drain to exterior through clean-out ports.
 - 2. During cold weather, remove ice and snow from within forms. Do not use de-icing salts. Do not use water to clean out forms unless formwork and concrete construction proceed within heated enclosure. Use compressed air or other means to remove foreign matter.
- C. Clean and repair surfaces of forms to be reused in the work. Split, frayed, delaminated, or otherwise damaged form facing material will not be acceptable. Remove such material from the site. Apply form release coating as specified for new formwork.
- D. Align and secure joints in a manner that will preclude offsets. Do not use patched forms

for exposed concrete surfaces.

3.07 FORMWORK TOLERANCES

- A. Construct formwork to maintain tolerances required by ACI 117, unless otherwise indicated.

3.08 FIELD QUALITY CONTROL

- A. An independent testing agency will perform field quality control tests, as specified in Section 01 43 00 – Quality Assurance and Qualifications.
- B. Before placing concrete, check lines and grades of erected formwork and positioning of embedded inserts, blockouts, and joints for correctness. Verify that embedded piping and conduit are free from obstruction. Make corrections or adjustments to ensure proper size and location of concrete members and stability of forming systems.
- C. While placing concrete, provide quality control to assure that formwork and related supports have not been displaced, that loss of cement paste through joints is prevented, and that completed work will be with specified tolerances.
- D. Inspect erected formwork, shoring, and bracing to ensure that work is in accordance with formwork design, and to verify that supports, fastenings, wedges, ties, and items are secure.

3.09 DETECTION OF MOVEMENT

- A. Check movement using methods, such as plumb lines, tell tales, and survey equipment, to detect movement of formwork during concrete placement.

3.10 FORM REMOVAL

- A. Do not remove forms or bracing until concrete has gained sufficient strength to carry its own weight and imposed loads.
- B. Remove forms by methods which will not injure, mar, gouge, or chip concrete surfaces, overstress concrete members, or distort formwork. Use air pressure or other approved methods. Do not pry against concrete. Cut off nails flush. Leave surfaces clean and unblemished.
- C. When repair of surface defects or finishing is required at an early age, forms may be removed as soon as the concrete has hardened sufficiently to resist damage from removal operations and its own weight.
 - 1. Concrete work that is damaged by removal operations shall be repaired as specified in Section 03 30 00 – Concrete. Where exposed surfaces are damaged beyond acceptable repairing measures, the damaged concrete shall be removed and repaired with new concrete.
- D. Loosen forms carefully. Do not wedge pry bars, hammers, or tools against finish concrete surfaces scheduled for exposure to view.

- E. Store removed forms to prevent damage to form materials or to fresh concrete. Discard damaged forms.

END OF SECTION 03 10 00

SECTION 03 10 00
CONCRETE FORMING AND ACCESSORIES (BUILDING)

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section Includes:

- 1. Shoring, bracing, and anchoring.

- B. Related Requirements:

- 1. Section 011100 "Summary of Work" for all Buy America Build America Act (BABA) requirements.
 - 2. Section 321313 "Concrete Paving" for formwork related to concrete pavement and walks.
 - 3. Section 321316 "Decorative Concrete Paving" for formwork related to decorative concrete pavement and walks.

1.03 DEFINITIONS

- A. Form-Facing Material: Temporary structure or mold for the support of concrete while the concrete is setting and gaining sufficient strength to be self-supporting.
- B. Formwork: The total system of support of freshly placed concrete, including the mold or sheathing that contacts the concrete, as well as supporting members, hardware, and necessary bracing.

1.04 ACTION SUBMITTALS

- A. Product Data: For each of the following:

- 1. Exposed surface form-facing material.
 - 2. Form ties.
 - 3. Waterstops.
 - 4. Form-release agent.

- B. Shop Drawings: Prepared by, and signed and sealed by, a qualified professional engineer responsible for their preparation, detailing fabrication, assembly, and support of forms.

- 1. For exposed vertical concrete walls, indicate dimensions and form tie locations.

2. Indicate dimension and locations of construction and movement joints required to construct the structure in accordance with ACI 301.
 - a. Location of construction joints is subject to approval of the Architect.
 3. Indicate location of waterstops.
 4. Indicate form liner layout and form line termination details.
 5. Indicate proposed schedule and sequence of stripping of forms, shoring removal, and reshoring installation and removal.
 6. Indicate layout of insulating concrete forms, dimensions, course heights, form types, and details.
- C. Samples:
1. For waterstops.
 2. For Form Liners: 12-inch by 12-inch sample, indicating texture.

1.05 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.
 1. QUALITY ASSURANCE
- B. Testing and Inspection Agency Qualifications: An independent agency, qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Form Liners: Store form liners under cover to protect from sunlight.
- B. Insulating Concrete Forms: Store forms off ground and under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.
- C. Waterstops: Store waterstops under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Concrete Formwork: Design, engineer, erect, shore, brace, and maintain formwork, shores, and reshores in accordance with ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads, so that resulting concrete conforms to the required shapes, lines, and dimensions.
 1. Design wood panel forms in accordance with APA's "Concrete Forming Design/Construction Guide."

2. Design formwork to limit deflection of form-facing material to 1/240 of center-to-center spacing of supports.
 - a. For architectural concrete specified in Section 033300 "Architectural Concrete," limit deflection of form-facing material, studs, and walers to 0.0025 times their respective clear spans (L/400).
- B. Design, engineer, erect, shore, brace, and maintain insulating concrete forms in accordance with ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads, so that resulting concrete conforms to the required shapes, lines, and dimensions.
 1. Design cross ties to transfer the effects of the following loads to the cast-in-place concrete core:
 - a. Wind Loads: As indicated on Drawings.
 - (1) Horizontal Deflection Limit: Not more than 1/600 of the wall height.

2.02 WATERSTOPS

- A. Self-Expanding Butyl Strip Waterstops: Manufactured rectangular or trapezoidal strip, butyl rubber with sodium bentonite or other hydrophilic polymers, for adhesive bonding to concrete, 3/4 by 1 inch.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Carlisle Coatings & Waterproofing Inc.
 - b. CETCO, a Minerals Technologies company.
 - c. Henry Company.
 - d. Sika Corporation.

2.03 RELATED MATERIALS

- A. Reglets: Fabricate reglets of not less than 0.022-inch- thick, galvanized-steel sheet. Temporarily fill or cover face opening of reglet to prevent intrusion of concrete or debris.
- B. Dovetail Anchor Slots: Hot-dip galvanized-steel sheet, not less than 0.034 inch thick, with bent tab anchors. Temporarily fill or cover face opening of slots to prevent intrusion of concrete or debris.
- C. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch, minimum.
- D. Rustication Strips: Wood, metal, PVC, or rubber strips, kerfed for ease of form removal.
- E. Form-Release Agent: Commercially formulated form-release agent that does not bond with, stain, or adversely affect concrete surfaces and does not impair subsequent treatments of concrete surfaces.

1. Formulate form-release agent with rust inhibitor for steel form-facing materials.
 2. Form release agent for form liners shall be acceptable to form liner manufacturer.
- F. Form Ties: Factory-fabricated, removable or snap-off, glass-fiber-reinforced plastic or metal form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.
1. Furnish units that leave no corrodible metal closer than 1 inch to the plane of exposed concrete surface.
 2. Furnish ties that, when removed, leave holes no larger than 1 inch in diameter in concrete surface.
 3. Furnish ties with integral water-barrier plates to walls indicated to receive dampproofing or waterproofing.

PART 3 - EXECUTION

3.01 INSTALLATION OF FORMWORK

- A. Comply with ACI 301.
- B. Construct formwork, so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117 and to comply with the Surface Finish designations specified in Section 033000 "Cast-In-Place Concrete" for as-cast finishes and Section 033300 "Architectural Concrete".
- C. Limit concrete surface irregularities as follows:
1. Surface Finish-1.0: ACI 117 Class D, 1 inch.
 2. Surface Finish-2.0: ACI 117 Class B, 1/4 inch.
 3. Surface Finish-3.0: ACI 117 Class A, 1/8 inch.
- D. Construct forms tight enough to prevent loss of concrete mortar.
1. Minimize joints.
 2. Exposed Concrete: Symmetrically align joints in forms.
- E. Construct removable forms for easy removal without hammering or prying against concrete surfaces.
1. Provide crush or wrecking plates where stripping may damage cast-concrete surfaces.
 2. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.
 3. Install keyways, reglets, recesses, and other accessories, for easy removal.

- F. Do not use rust-stained, steel, form-facing material.
- G. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces.
 - 1. Provide and secure units to support screed strips
 - 2. Use strike-off templates or compacting-type screeds.
- H. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible.
 - 1. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar.
 - 2. Locate temporary openings in forms at inconspicuous locations.
- I. Chamfer exterior corners and edges of permanently exposed concrete.
- J. At construction joints, overlap forms onto previously placed concrete not less than 12 inches.
- K. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work.
 - 1. Determine sizes and locations from trades providing such items.
 - 2. Obtain written approval of Architect prior to forming openings not indicated on Drawings.
- L. Construction and Movement Joints:
 - 1. Construct joints true to line with faces perpendicular to surface plane of concrete.
 - 2. Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.
 - 3. Place joints perpendicular to main reinforcement.
 - 4. Locate joints for beams, slabs, joists, and girders in the middle third of spans.
 - a. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
 - 5. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
 - 6. Space vertical joints in walls as indicated on Drawings .
 - a. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.

- M. Provide temporary ports or openings in formwork where required to facilitate cleaning and inspection.
 - 1. Locate ports and openings in bottom of vertical forms, in inconspicuous location, to allow flushing water to drain.
 - 2. Close temporary ports and openings with tight-fitting panels, flush with inside face of form, and neatly fitted, so joints will not be apparent in exposed concrete surfaces.
- N. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.
- O. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.
- P. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

3.02 INSTALLATION OF EMBEDDED ITEMS

- A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete.
 - 1. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 2. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC 303.
 - 3. Install reglets to receive waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.
 - 4. Install dovetail anchor slots in concrete structures, as indicated on Drawings.
 - 5. Clean embedded items immediately prior to concrete placement.

3.03 INSTALLATION OF WATERSTOPS

- A. Flexible Waterstops: Install in construction joints and at other joints indicated to form a continuous diaphragm.
 - 1. Install in longest lengths practicable.
 - 2. Locate waterstops in center of joint unless otherwise indicated on Drawings.
 - 3. Allow clearance between waterstop and reinforcing steel of not less than 2 times the largest concrete aggregate size specified in Section 033000 "Cast-In-Place Concrete."
 - 4. Secure waterstops in correct position at 12 inches on center.

5. Field fabricate joints in accordance with manufacturer's instructions using heat welding.
 - a. Miter corners, intersections, and directional changes in waterstops.
 - b. Align center bulbs.
 6. Clean waterstops immediately prior to placement of concrete.
 7. Support and protect exposed waterstops during progress of the Work.
- B. Self-Expanding Strip Waterstops: Install in construction joints and at other locations indicated on Drawings, according to manufacturer's written instructions, by adhesive bonding, mechanically fastening, and firmly pressing into place.
1. Install in longest lengths practicable.
 2. Locate waterstops in center of joint unless otherwise indicated on Drawings.
 3. Protect exposed waterstops during progress of the Work.

3.04 REMOVING AND REUSING FORMS

- A. Formwork for sides of beams, walls, columns, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F for 24 hours after placing concrete. Concrete has to be hard enough to not be damaged by form-removal operations, and curing and protection operations need to be maintained.
1. Leave formwork for beam soffits, joists, slabs, and other structural elements that support weight of concrete in place until concrete has achieved at least 70 percent of its 28-day design compressive strength.
 2. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.
- B. Clean and repair surfaces of forms to be reused in the Work.
1. Split, frayed, delaminated, or otherwise damaged form-facing material are unacceptable for exposed surfaces.
 2. Apply new form-release agent.
- C. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints.
1. Align and secure joints to avoid offsets.
 2. Do not use patched forms for exposed concrete surfaces unless approved by Architect.

3.05 SHORING AND RESHORING INSTALLATION

- A. Comply with ACI 318 and ACI 301 for design, installation, and removal of shoring and reshoring.
 - 1. Do not remove shoring or reshoring until measurement of slab tolerances is complete.
- B. In multistory construction, extend shoring or reshoring over a sufficient number of stories to distribute loads in such a manner that no floor or member will be excessively loaded or will induce tensile stress in concrete members without sufficient steel reinforcement.
- C. Plan sequence of removal of shores and reshore to avoid damage to concrete. Locate and provide adequate reshoring to support construction without excessive stress or deflection.

3.06 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. Inspections:
 - 1. Inspect formwork for shape, location, and dimensions of the concrete member being formed.
 - 2. Inspect insulating concrete forms for shape, location, and dimensions of the concrete member being formed.

END OF SECTION 03 10 00

SECTION 03 20 00
REINFORCING (SITE)

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Furnish all labor, materials, equipment, tools and services required to fully complete all Reinforcing work as required by the Drawings and/or specified herein including, but not limited to, the following described items.
- B. Reinforcing steel for cast-in-place concrete.
- C. Supports and accessories for steel reinforcement.

1.02 RELATED REQUIREMENTS

- A. Section 01 11 00 – Summary of Work
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) Requirements
- B. Section 03 10 00 – Concrete Forming and Accessories.
- C. Section 03 30 00 – Cast-In-Place Concrete

1.03 SUBMITTALS

- A. See Section 01 33 00 – Submittal Procedures, for submittal procedures.
- B. Shop Drawings: Comply with requirements of ACI SP-66. Include bar schedules, shapes of bent bars, spacing of bars, and location of splices.
- C. Manufacturer’s Certificate: Certify that reinforcing steel and accessories supplied for this project meet or exceed specified requirements.
- D. Reports: Submit certified copies of mill test report or reinforcement materials analysis.

1.04 QUALITY ASSURANCE

- A. Perform work of this section in accordance with ACI 301.
 - 1. Maintain one copy of each document on project site.

PART 2 - PRODUCTS

2.01 REINFORCEMENT

- A. Reinforcing steel: ASTM A615/A615M, Grade 60 (60,000 psi)
 - 1. Deformed billet-steel bars.

2. Unfinished.
- B. Stirrup Steel: ASTM A1064/A1064M steel wire, unfinished.
 - C. Reinforcement Accessories:
 1. Tie Wire: Annealed, minimum 16 gage, 0.0508 inch.
 2. Chairs, Bolsters, Bar Supports, Spacers: Sized and shaped for adequate support of reinforcement during concrete placement.
 3. Provide stainless steel or stainless steel components for placement within 1-1/2 inches of weathering surfaces.

2.02 FABRICATION

- A. Fabricate concrete reinforcing in accordance with ACI 318.
- B. Welding of reinforcement is not permitted, except where noted on Drawings. Where reinforcing is welded, use ASTM A-706 reinforcing.
- C. Locate reinforcing splices not indicated on drawings at point of minimum stress.
 1. Review locations of splices with Architect.

PART 3 - EXECUTION

3.01 PLACEMENT

- A. Place, support and secure reinforcement against displacement. Do not deviate from required position.
- B. Do not displace or damage vapor barrier.
- C. Accommodate placement of formed openings.
- D. Maintain concrete cover around reinforcing as shown on Structural Drawings.
- E. Comply with applicable code for concrete cover over reinforcement.

3.02 FIELD QUALITY CONTROL

- A. An independent testing agency, as specified in Section 01 43 00 – Quality Assurance and Qualifications, will inspect installed reinforcement for conformance to contract document before concrete placement.
- B. Refer to Structural Drawings for special inspection requirements.

END OF SECTION 03 20 00

SECTION 03 20 00
CONCRETE REINFORCING (BUILDING)

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section Includes:

1. Steel reinforcement bars.

- B. Related Requirements:

1. Section 011100 "Summary of Work" for all Buy America Build America Act (BABA) requirements.
2. Section 033816 "Unbonded Post-Tensioned Concrete" for reinforcing related to post-tensioned concrete.
3. Section 034100 "Precast Structural Concrete" for reinforcing used in precast structural concrete.
4. Section 034500 "Precast Architectural Concrete" for reinforcing used in precast architectural concrete.
5. Section 321313 "Concrete Paving" for reinforcing related to concrete pavement and walks.
6. Section 321316 "Decorative Concrete Paving" for reinforcing related to decorative concrete pavement and walks.

1.03 ACTION SUBMITTALS

- A. Product Data: For the following:

1. Each type of steel reinforcement.
2. Bar supports.

- B. Shop Drawings: Comply with ACI SP-066:

1. Include placing drawings that detail fabrication, bending, and placement.
2. Include bar sizes, lengths, materials, grades, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, location of splices, lengths of lap splices, details of mechanical splice couplers, details of welding splices, tie spacing, hoop spacing, and supports for concrete reinforcement.

3. For structural thermal break insulated connection system, indicate general configuration, insulation dimensions, tension bars, compression pads, shear bars, and dimensions.
- C. Construction Joint Layout: Indicate proposed construction joints required to build the structure.
1. Location of construction joints is subject to approval of the Architect.

1.04 INFORMATIONAL SUBMITTALS

- A. Qualification Statements: For .
- B. Material Certificates: For each of the following, signed by manufacturers:
1. Epoxy-Coated Reinforcement: CRSI's "Epoxy Coating Plant Certification."
 2. Dual-Coated Reinforcement: CRSI's "Epoxy Coating Plant Certification."
- C. Field quality-control reports.

1.05 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage.
1. Store reinforcement to avoid contact with earth.
 2. Do not allow epoxy-coated reinforcement to be stored outdoors for more than 60 days without being stored under an opaque covering.
 3. Do not allow dual-coated reinforcement to be stored outdoors for more than 60 days without being stored under an opaque covering.
 4. Do not allow stainless steel reinforcement to come into contact with uncoated reinforcement.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

2.02 STEEL REINFORCEMENT

- A. Reinforcing Bars: ASTM A615/A615M, Grade 60 , deformed.

2.03 REINFORCEMENT ACCESSORIES

- A. Joint Dowel Bars: ASTM A615/A615M, Grade 60, plain-steel bars, cut true to length with ends square and free of burrs.
- B. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded-wire reinforcement in place.
 - 1. Manufacture bar supports from steel wire, plastic, or precast concrete in accordance with CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:
 - a. For concrete surfaces exposed to view, where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire, all-plastic bar supports, or CRSI Class 2 stainless steel bar supports.
 - b. For epoxy-coated reinforcement, use CRSI Class 1A epoxy-coated or other dielectric-polymer-coated wire bar supports.
 - c. For dual-coated reinforcement, use CRSI Class 1A epoxy-coated or other dielectric-polymer-coated wire bar supports.
 - d. For zinc-coated reinforcement, use galvanized wire or dielectric-polymer-coated wire bar supports.
 - e. For stainless steel reinforcement, use CRSI Class 1 plastic-protected steel wire, all-plastic bar supports, or CRSI Class 2 stainless steel bar supports.
- C. Steel Tie Wire: ASTM A1064/A1064M, annealed steel, not less than 0.0508 inch in diameter.
 - 1. Finish: Plain ASTM A884/A884M, Class A, Type 1, epoxy coated, with less than 2 percent damaged coating in each 12-inch wire length.

2.04 FABRICATING REINFORCEMENT

- A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

PART 3 - EXECUTION

3.01 PREPARATION

- A. Protection of In-Place Conditions:
 - 1. Do not cut or puncture vapor retarder.
 - 2. Repair damage and reseal vapor retarder before placing concrete.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that reduce bond to concrete.

3.02 INSTALLATION OF STEEL REINFORCEMENT

- A. Comply with CRSI's "Manual of Standard Practice" for placing and supporting reinforcement.
- B. Accurately position, support, and secure reinforcement against displacement.
 - 1. Locate and support reinforcement with bar supports to maintain minimum concrete cover.
 - 2. Do not tack weld crossing reinforcing bars.
- C. Preserve clearance between bars of not less than 1 inch, not less than one bar diameter, or not less than 1-1/3 times size of large aggregate, whichever is greater.
- D. Provide concrete coverage in accordance with ACI 318.
- E. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.
- F. Splices: Lap splices as indicated on Drawings.
 - 1. Bars indicated to be continuous, and all vertical bars shall be lapped not less than 36 bar diameters at splices, or 24 inches, whichever is greater.
 - 2. Stagger splices in accordance with ACI 318.
 - 3. Mechanical Splice Couplers: Install in accordance with manufacturer's instructions.
 - 4. Weld reinforcing bars in accordance with AWS D1.4/D 1.4M, where indicated on Drawings.
- G. Install structural thermal break insulated connection system in accordance with manufacturer's instructions.

3.03 JOINTS

- A. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.
 - 1. Place joints perpendicular to main reinforcement.
 - 2. Continue reinforcement across construction joints unless otherwise indicated.
 - 3. Do not continue reinforcement through sides of strip placements of floors and slabs.
- B. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt coat one-half of dowel length, to prevent concrete bonding to one side of joint.

3.04 INSTALLATION TOLERANCES

- A. Comply with ACI 117.

3.05 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. Inspections:
 - 1. Steel-reinforcement placement.
 - 2. Steel-reinforcement welding.
- C. Manufacturer's Inspections: Engage manufacturer of structural thermal break insulated connection system to inspect completed installations prior to placement of concrete, and to provide written report that installation complies with manufacturer's written instructions.

END OF SECTION 03 20 00

SECTION 03 21 11
CONCRETE REINFORCEMENT

PART 1 - GENERAL

1.01 THE REQUIREMENT

- A. Furnish, fabricate and place all concrete reinforcing steel, welded wire fabric, couplers, and concrete inserts for use in reinforced concrete and perform all appurtenant work, including all the wires, clips, supports, chairs, spacers, and other accessories, all in accordance with the Contract Documents.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. Without limiting the generality of other requirements of these specifications, all Work specified herein shall conform to or exceed the requirements of the Florida Building Code and the applicable requirements of the following documents to the extent that the provisions of such documents are not in conflict with the requirements of this Section.

- 1. Codes and Standards

- a. The Building Code, as referenced herein, is the Florida Building Code (FBC).

- 2. Commercial Standards

ACI 315R	Details and Detailing of Concrete Reinforcement.
CRSI	Concrete Reinforcing Steel Institute Manual of Standard Practice
ACI 305R	Hot Weather Concreting
ACI 318R	Building Code Requirements for Reinforced Concrete.
ACI 350R-	Code Requirements for Environmental Engineering Concrete Structures
WRI	Manual of Standard Practice for Welded Wire Fabric.
AWS DI.4	Structural Welding Code - Reinforcing Steel.
ASTM A 185	Specification for Welded Steel Wire Fabric for Concrete Reinforcement.
ASTM A 615	Specification for Deformed and Plain Billet-Steel Bars for Concrete reinforcement.

1.03 SUBMITTALS

- A. Furnish shop bending diagrams, placing lists, and Drawings of all reinforcing steel prior to fabrication in accordance to the Conditions of the Contract and Division 1

Specification Sections.

- B. Details of the concrete reinforcing steel and concrete inserts to be submitted by the Contractor at the earliest possible date after receipt by the Contractor of the Notice to Proceed. Said details of reinforcing steel for fabrication and erection shall conform to ACI 315 and the requirements specified and shown. The shop bending diagrams shall show the actual lengths of bars, to the nearest inch measured to the intersection of the extensions (tangents for bars of circular cross section) of the outside surface. The shop Drawings shall include bar placement diagrams which clearly indicate the dimensions of each bar splice.
- C. Where mechanical couplers are shown on the Drawings to be used to splice reinforcing steel, submit manufacturer's literature which contains instructions and recommendations for installation for each type of coupler used; certified test reports which verify the load capacity of each type and size of coupler used; and shop Drawings which show the location of each coupler with details of how they are to be installed in the formwork.
- D. If reinforcing steel is spliced by welding at any location, submit mill test reports which shall contain the information necessary for the determination of the carbon equivalent as specified in AWS D1.4. Submit a written welding procedure for each type of weld for each size of bar which is to be spliced by welding, merely a statement that AWS procedures will be followed is not acceptable. Welding of rebar shall be done only where shown on the Drawings or allowed in writing by the Engineer.

PART 2 - PRODUCTS

2.01 REINFORCEMENT

- A. All reinforcing steel for all reinforced concrete construction shall conform to the following requirements:
 - 1. Bar reinforcement shall conform to the requirements of ASTM A 615 for Grade 60 Billet Steel Reinforcement with supplementary requirement S-1, and shall be manufactured in the United States.
 - 2. Welded wire fabric reinforcement shall conform to the requirements of ASTM A 185 and the details shown on the Drawings; provided, that welded wire fabric shall be furnished in flat sheets only. All welded wire fabric reinforcement shall be galvanized.

2.02 ACCESSORY MATERIALS

- A. Bolsters, chairs, spacers and other devices for supporting and fastening reinforcing in place shall be galvanized wire type complying with CRSI recommendations on grade with gray plastic tipped legs.
- B. Tie Wire: Galvanized 16 gauge annealed type.
- C. Concrete blocks (dobies), used to support and position reinforcing steel, shall have the same or higher compressive strength as specified for the concrete in which it is located. Concrete blocks shall only be used bottom mat of reinforcing steel for slabs on grade.

- D. Couplers used to mechanically splice reinforcing steel shall be Linton Standard Copier - A2 manufactured by ERICO Products, inc. or equal. Bars shall be shop threaded to receive couplers.

2.03 FABRICATION

- A. Reinforcing steel shall be accurately formed to the dimensions and shapes shown on the Drawings, and the fabricating details shall be prepared in accordance with ACI 315, ACI 318, and ACI 350 except as modified by the Drawings. Stirrups and tie bars shall be bent around a pin having a diameter not less than 1-1/2 inch for No.3 bars, 2-inch for No.4 bars, and 2-1/2 inch for No.5 bars. Bends for other bars shall be made around a pin having a diameter not less than 6 times the minimum thickness, except for bars larger than 1 inch, in which case the bends shall be made around a pin of 8 bar diameters. Bars shall be bent cold.
- B. Fabricate reinforcing bars for structures in accordance with bending diagrams, placing lists, and placing Drawings. Said Drawings, diagrams, and lists to be prepared by the Contractor as specified under Section entitled "Submittals," herein.
- C. Fabricating Tolerances: Bars used for concrete reinforcing shall meet the following requirements for fabricating tolerances:
 - 1. Sheared length: + 1 inch
 - 2. Depth of bars: + 0, - 1/2 inch
 - 3. Stirrups and ties: + 1/2 inch
 - 4. All other bends: + 1 inch

PART 3 - EXECUTION

3.01 PLACEMENT

- A. Reinforcing steel shall be accurately positioned as shown on the Drawings, and shall be supported and wired together to prevent displacement, using annealed iron wire ties or suitable clips at intersections. All reinforcing steel shall be supported by concrete, plastic or metal supports, spacers or metal hangers which are strong and rigid enough to prevent any displacement of the reinforcing steel. Where concrete is to be placed on the ground, supporting concrete blocks (or dobies) shall be used, in sufficient numbers to support the bars without settlement, but in no case shall such support be continuous. All concrete blocks used to support reinforcing steel shall be tied to the steel with wire ties which are embedded in the blocks. For concrete over formwork, furnish concrete, metal, plastic, or other acceptable bar chairs and spacers.
- B. Tie wires shall be bent away from the forms in order to provide the specified concrete coverage.
- C. Bars additional to those shown on the Drawings which may be found necessary or desirable by the Contractor for the purpose of securing reinforcement in position to be provided by the Contractor at its own expense.

- D. Unless otherwise specified, reinforcement placing tolerances shall be within the limits specified in Section 7.5 of ACI 318 except where in conflict with the requirements of the Building Code.
- E. Bars may be moved as necessary to avoid interference with other reinforcing steel, conduits, or embedded items. If bars are moved more than one bar diameter, or enough to exceed the above tolerances, the resulting arrangement of bars shall be as acceptable to the Engineer.
- F. Welded wire fabric reinforcement placed over horizontal forms shall be supported on slab bolsters having gray, plastic-coated standard type legs as specified in Paragraph B herein. Slab bolsters shall be spaced not less than 30 inches on centers, shall extend continuously across the entire width of the reinforcing mat, and shall support the reinforcing mat in the plane shown on the Drawings.
- G. Welded wire fabric placed over the ground shall be supported on wired concrete blocks (dobies) spaced not more than 3 feet on centers in any direction. The construction practice of placing welded wire fabric on the ground and hooking into place in the freshly placed concrete shall not be used.
- H. The clear distance between parallel bars (except in columns and between multiple layers of bars in beams) shall be not less than the nominal diameter of the bars nor less than 1-1/3 times the maximum size of the coarse aggregate, nor less than one inch.
- I. Where reinforcement in beams or girders is placed in 2 or more layers, the clear distance between layers shall be not less than one inch.
- J. In columns, the clear distance between longitudinal bars shall be not less than 1-1/2 times the bar diameter, nor less than 1-1/2 times the maximum size of the coarse aggregate, nor less than 1-1/2 inches.
- K. The clear distance between bars shall also apply to the distance between a contact splice and adjacent splices or bars.
- L. Reinforcing bar splices shall only be used at locations shown on the Drawings. When it is necessary to splice reinforcement at points other than where shown, the character of the splice shall be as acceptable to the Engineer.
- M. The length of lap for reinforcing bars, unless otherwise shown on the Drawings shall be in accordance with ACI 318, Section 12.15.1 for a class B splice.
- N. Laps of welded wire fabric shall be in accordance with the ACI 318. Adjoining sheets shall be securely tied together with No. 14 tie wire, one tie for each 2 running feet. Wires shall be staggered and tied in such a manner that they cannot slip.
- O. Reinforcing shall not be straightened or rebent in a manner which will injure the material. Bars with kinks or bends not shown on the Drawings shall not be used. All bars shall be bent cold, unless otherwise permitted by the Engineer. No bars partially embedded in concrete shall be field-bent except as shown on the Drawings or specifically permitted by the Engineer.

3.02 CLEANING AND PROTECTION

- A. Reinforcing steel shall at all times be protected from conditions conducive to corrosion until concrete is placed around it.
- B. The surfaces of all reinforcing steel and other metalwork to be in contact with concrete shall be thoroughly cleaned of all dirt, grease, loose scale and rust, grout, mortar and other foreign substances immediately before the concrete is placed. Where there is delay in depositing concrete, reinforcing shall be reinspected and, if necessary recleaned.

END OF SECTION 03 21 11

SECTION 03 29 00
UNDER-SLAB VAPOR BARRIER/RETARDER

PART 1 - GENERAL

1.01 SUMMARY

A. Products Supplied Under This Section

1. Vapor Barrier, seam tape, pipe boots, detail strip for installation under concrete slabs.

B. RELATED SECTIONS

1. Section 03 30 00 Cast-in-place Structural Concrete
2. Section 07 26 16 Under-Slab Vapor Barrier

1.02 REFERENCES

A. American Society for Testing and Materials (ASTM)

1. ASTM E 1745-97 Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil
2. Or Granular Fill Under Concrete Slabs
3. ASTM E 154-88 Standard Test Methods for Water Vapor Retarders Used in Contact with Earth Under Concrete Slabs
4. ASTM E 96-95 Standard Test Methods for Water Vapor Transmission of Materials
5. ASTM E 1643-98 Standard Practice for Installation of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs

B. American Concrete Institute (ACI)

1. ACI 302.1R-96 Vapor Barrier Component (plastic membrane) is not less than 10 mils thick

1.03 SUBMITTALS

A. Quality Control / Assurance

1. Independent laboratory test results showing compliance with ASTM & ACI Standards.
2. Manufacturer's samples, literature
3. Manufacturer's installation instructions for placement, seaming and pipe boot installation

PART 2 - PRODUCTS

2.01 MATERIALS

A. Vapor Barrier (Performance based specification)

1. Vapor Barrier membrane must have the following properties.

- a. Minimum 15-mil thick polyolefin geomembrane
- b. Manufactured from prime virgin resins
- c. Water Vapor Barrier ASTM E-1745 Meets or exceeds Class B
- d. Water Vapor Transmission Rate ASTM E-96 0.006 gr./ft²/hr. or lower
- e. Permeance Rating ASTM E-96 0.01 gr./ft²/hr. or lower
- f. Puncture Resistance ASTM E-1745 minimum 1970 grams
- g. Tensile Strength ASTM E-1745 minimum 45.0 lbf/in

2.02 ACCESSORIES

A. Seam Tape

1. High Density Polyethylene Tape with pressure sensitive adhesive. Minimum width 4 inches.

B. Pipe Boots

1. Construct pipe boots from vapor barrier material and pressure sensitive tape per manufacturer's instructions.

PART 3 - EXECUTION

3.01 PREPARATION

A. Ensure that subsoil is approved by architect

1. Level and tamp or roll aggregate, sand or tamped earth base.

3.02 INSTALLATION

A. Install Vapor Barrier:

1. Installation shall be in accordance with manufacturer's instructions and ASTM E 1643-98.
 - a. Unroll Vapor Barrier with the longest dimension parallel with the direction of the pour.

- b. Lap Vapor Barrier over footings and seal to foundation walls.
- c. Overlap joints 6 inches and seal with manufacturer's tape.
- d. Seal all penetrations (including pipes) with manufacturer's pipe boot.
- e. No penetration of the vapor barrier is allowed except for reinforcing steel and permanent utilities.
- f. Repair damaged areas by cutting patches of vapor barrier, overlapping damaged area 6 inches and taping all four sides with tape.

END OF SECTION 03 29 00

SECTION 03 30 00
CAST-IN-PLACE CONCRETE (SITE)

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Provide all labor, materials, equipment, fabrication, incidentals, transportation, placing and supervision necessary to complete all cast-in-place concrete work, its finishing, and all related work called for by the Contract Drawings and/or Specifications, or reasonably inferable from either or both, as needed for a complete and proper installation. Including, but not limited to, the following described items:
- B. Joint devices associated with concrete work.
- C. Miscellaneous concrete elements, including equipment pads, light pole bases, flagpole bases, thrust blocks, and bollards.
- D. Underslab vapor barrier.
- E. Water Stops.
- F. Concrete Curing.

1.02 RELATED REQUIREMENTS

- A. Section 01 11 00 – Summary of Work
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) Requirements
- B. Section 03 10 00 – Concrete Forming and Accessories
- C. Section 03 20 00 – Reinforcing.
- D. Section 32 13 13 – Concrete Paving

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Preinstallation Meeting: Convene one week before starting work of this section.
 - 1. Topics for discussion may include: design mixture, placement schedule, placement methods, tolerances, curing method, jointing, and slab protection.
 - 2. Minutes of the meeting shall be recorded, typed, and distributed by the General Contractor to all concerned parties, including but not limited to the Owner’s Representative, Architect, and all attendees within 5 days of the meeting.

1.04 SUBMITTALS

- A. See Section 01 33 00 – Submittal Procedures for submittal procedures.

- B. Product Data: Submit manufacturers' data on manufactured products showing compliance with specified requirements and installation instructions.
- C. Mix Design: Submit proposed concrete mix design.
 - 1. Indicate proposed mix design complies with requirements of ACI 301, Section 4-Concrete Mixtures.
 - 2. Indicate Proposed mix design complies with requirements of ACI 318, Chapter 5-Concrete Quality, Mixing and Placing.
- D. Shop Drawings: Submit plans showing locations of construction and control joints for Engineer/Owner Review.
- E. Samples: Submit samples of underslab vapor retarder to be used.
- F. Samples: Submit two, 12-inch long samples of construction joint devices.
- G. Test Reports: Submit report for each test or series of tests specified.
- H. Manufacturer's Installation Instructions: For concrete accessories, indicate installation procedures and interface required with adjacent construction.
- I. Project Record Documents: Accurately record actual locations of embedded utilities and components that will be concealed from view upon completion of concrete work.

1.05 QUALITY ASSURANCE

- A. Perform work of this section in accordance with ACI 301 and ACI 318.
 - 1. Maintain one copy of each document on site.
- B. Follow recommendations of ACI 305R when concreting during hot weather.
- C. Follow recommendations of ACI 306R when concreting during cold weather.
- D. Vapor Barrier Installation: Conduct pre-installation conference and installation review prior to concrete placement, either in-person or digitally.

1.06 WARRANTY

- A. See Section 01 78 00 – Closeout Submittals, for additional warranty requirements.

PART 2 - PRODUCTS

2.01 FORMWORK

- A. Comply with requirements of Section 03 10 00.

2.02 REINFORCEMENT MATERIALS

- A. Comply with requirements of Section 03 20 00.

2.03 CONCRETE MATERIALS

- A. Cement: ASTM C150/C150M, Type I – Normal or Type II – Moderate Portland type.
 - 1. Acquire cement for entire project from same source.
- B. Fine and Course Aggregates: ASTM C33/C33M
 - 1. Acquire aggregates for entire project from same source.
- C. Fly Ash: ASTM C618, Class F.
- D. Water: ASTM C1602/C1602M; clean, potable, and not detrimental to concrete.

2.04 ADMIXTURES

- A. Chemical Admixture:
 - 1. Manufacturers:
 - a. Sika Corporation
 - b. GCP Applied Technologies
 - c. BASF Chemical Company
 - d. Euclid Chemical Company
 - e. Substitutions: See Section 01 60 00 – Product Requirements.
- B. Do not use chemicals that will result in soluble chloride ions in excess of 0.05 percent by weight of cement.
- C. All admixtures to come from same manufacturer. Verify the admixtures are compatible.
- D. Coordinate admixtures with requirements of waterproofing membrane.
- E. Air Entrainment Admixture: ASTM C260/C260M.
 - 1. Certification attesting to compliance with ASTM C260/C260M shall be furnished.
 - 2. All exterior concrete flatwork, curbs and gutters, and catch basins shall have an air-entraining agent added which will yield entrainment.
 - 3. Manufacturers:
 - a. “Airalon 3000” manufactured by GCP Applied Technologies.
- F. Water Reducing (set controlling) Admixtures:
 - 1. Concrete shall be adjusted to produce the required rate of hardening for varied climatic and job site conditions.

2. Admixture shall not reduce the amount of cement required. Amounts as accepted by Architect/Engineer. Do not use calcium chloride or admixtures that contain calcium chloride.
3. Field Service, when requested, a qualified concrete technician, employed by the manufacturer, shall be available to assist in proportioning concrete materials for optimum use, to advise on proper use of the admixture and adjustment of concrete mix proportions to meet the jobsite and climatic conditions.
4. High range Water Reducing Admixture: ASTM C494/C494M Type F.
 - a. Approval in writing required from Architect.
5. Water Reducing and Accelerating Admixture: ASTM C494/C494M Type E.
 - a. Under 40 degrees F ambient temperature – Accelerate (Approval in writing required from Architect).
6. Water Reducing and Retarding Admixture: ASTM C494/C494M Type D.
 - a. Over 80 degrees F ambient temperature – Retard.
7. Water Reducing Admixture: ASTM C494/C494M Type A.
 - a. Between 40 degrees F and 80 degrees F ambient temperature – Normal rate of hardening.
8. Shrinkage Reducing Admixture:
 - a. ASTM C494/C494M, Type S.
 - b. Manufacturers:
 - (1) GCP Applied Technologies; Eclipse 4500
 - (2) Substitutions: See Section 01 60 00 – Product Requirements.
9. Waterproofing Admixture: Admixture formulated to reduce permeability to liquid water, with no adverse effect on concrete properties.
 - a. Admixture Composition: Crystalline, functioning by growth of crystals in capillary pores.
 - b. Permeability of Cured Concrete: No measurable leakage when tested in accordance with COE CRD-C 48 at 200 psi; provide test reports.
 - c. Manufacturers:
 - (1) Xypex Chemical Corporation; XYPEX Admix C-500
 - (2) Xypex Chemical Corporation; XYPEX Admix C-1000

(3) Substitutions: See Section 01 60 00 – Product Requirements.

2.05 ACCESSORY MATERIALS

- A. Underslab Vapor Barrier: 20 mil high performance multi-layered virgin polyolefin, complying with ASTM E1745, Class A; stated by manufacturer as suitable for installation in contact with soil or granular fill under concrete slabs. Maintain water vapor permeance less than 0.03 perms before and after mandatory conditioning testing per ASTM E1745 Section 7.1. Single ply polyethylene is prohibited.
1. To be installed under all Slabs on Grade.
 2. Installation: Comply with ASTM E1643.
 3. Accessory Products: Vapor barrier manufacturer’s recommended tape, adhesive, mastic, prefabricated boots, etc., for sealing seams and penetrations in vapor barrier.
 4. Manufacturers:
 - a. GCP Applied Technologies; “GCP Florprufe 120”.
 - b. Stego Industries, LLC’ 20 mil Vapor Barrier.
 - c. Substitutions: Not permitted.
- B. Non-Shrink Epoxy Grout: Moisture-insensitive, two-part; consisting of epoxy resin, non-metallic aggregate, and activator.
1. During epoxy mixing and application process follow the epoxy manufacturer’s instructions exactly.
 2. All bars anchored in epoxy are to be inspected by the Special Inspector prior to covering up.
 3. Manufacturers:
 - a. Hilti Corporation; Product – “HIT RE 500-V3” or “HIT-HY-200A”
 - b. Simpson Corporation; Product – “SET-3G” or “AT-XP”
 - c. Dewalt Corporation; Product – “Pure 110+” or “AC200+ Gold”
 - d. Substitutions: See Section 01 60 00 – Product Requirements.

2.06 BONDING AND JOINTING PRODUCTS

- A. Epoxy Bonding System:
1. Complying with ASTM C881/C881M and of Type required for specific application and moisture insensitive.

2. Manufacturers:
 - a. Euclid Chemical Company; Product – “Duralcrete Epoxy System”
 - b. Substitutions: See Section 01 60 00 – Product Requirements.
- B. Waterstops: Hydrophilic rubber waterstop, complying with the following:
 1. Physical Properties:
 - a. Hydrostatic Head Resistance: 231 Feet (70 m).
 - b. Wet-Dry Cycling (25 cycles @ 231 feet (70 m)): No Effect.
 - c. Adhesion to Concrete using Manufacturers Adhesive: Excellent.
 2. Adhesive: As recommended by Manufacturer.
 3. Products: As manufactured or recommended by the below-grade waterproofing manufacturer.
- C. Waterstops: Sodium bentonite and butyl rubber compound formed into uniform coils, conforming to the requirements of NSF 61.
 1. Size and Configuration: AS required for specific application.
 2. Adhesive: Multi-purpose UV stable single component polyether moisture cure sealant/adhesive as recommended by manufacturer.
 3. Products: As manufactured or recommended by the below-grade waterproofing manufacturer.
- D. Slab Isolation Joint Filler: 1/2 inch thick, height equal to slab thickness, with removable top section that will form 1/2 inch deep sealant pocket after removal.
 1. Material: ASTM D1751, cellulose fiber.
- E. Slab Contraction Joint Device: Preformed linear strip intended for pressing into wet concrete to provide straight route for shrinkage cracking.

2.07 CURING MATERIALS

- A. Curing materials must be approved by adhesive and flooring manufacturers.
- B. Coordinate curing materials with requirements of waterproofing membrane.
- C. Evaporation Retarder: Liquid thin-fil-forming compound that reduces rapid moisture loss caused by high temperature, low humidity, and high winds; intended for application immediately after concrete placement.
 1. Manufacturers:

- a. Dayton Superior Corporation
 - b. Euclid Chemical Company
 - c. SpecChem, LLC
 - d. W.R. Meadows, Inc.
 - e. Substitutions: See Section 01 60 00 – Product Requirements.
- D. Curing Compound, Naturally Dissipating: Clear, water-based, liquid membrane-forming compound, that dissipates within 3 to 5 weeks; complying with ASTM C309, Type I, Classes A and B.
1. Manufacturers:
 - a. Dayton Superior Corporation
 - b. Euclid Chemical Company
 - c. Kaufman Products, Inc.
 - d. SpecChem, LLC
 - e. W.R. Meadows, Inc.
 - f. Substitutions: See Section 01 60 00 – Product Requirements.
- E. Removable Curing Compound: VOC compliant curing compound designed to be easily removed by the application of a cleaner/remover for all slabs that will receive stains, dyes, sealers, densifiers, coatings, or adhesives. For interior use only.
1. Products:
 - a. Euclid Chemical Company
 - (1) Removable Curing Compound: Kurez RC-100
 - (2) Cleaner/Remover: Kurez RC-off
 - b. Substitutions: See Section 01 60 00 – Product Requirements.
- F. Curing Compound, Non-dissipating: Liquid, membrane-forming, clear, non-yellowing acrylic; complying with ASTM C309.
1. Vehicle: Water-based.
 2. Gloss: Low.
 3. Solids by Mass: 15 percent, minimum.
 4. VOC Content: OTC compliant.

5. Manufacturers:
 - a. Kaufman Products, Inc; Krystal 15 Emulsion.
 - b. L&M Construction Chemicals, Inc. a subsidiary of Laticrete international, Inc; Dress & Seal WB.
 - c. L&M Construction Chemicals, Inc. a subsidiary of Laticrete international, Inc; Dress & Seal WB 30.
 - d. The QUIKRETE Companies; QUIKRETE ® Acrylic Concrete Cure & Seal.
 - e. W.R. Meadows, Inc; VOCOMP-20.
 - f. Substitutions: See Section 01 60 00 – Product Requirements.

G. Curing and Sealing Compound – Site Concrete

1. Refer to Section 32 13 13 – Concrete Paving and Site Elements.

H. Moisture-Retaining Sheet: ASTM C171.

1. White-burlap-polyethylene sheet, weighing not less than 3.8 ounces per square yard.

I. Water: Potable, not detrimental to concrete.

2.08 CONCRETE MIX DESIGN

A. General Concrete Mix Requirements:

1. Design of concrete mixes. Including recommended amounts of admixture and water to be used in the mixes, shall be obtained by the Contractor from a qualified independent testing laboratory or agency, or from a mill or ready-mix plant, properly equipped to design concrete mixes. The design shall be performed and certified by a professional engineer currently registered as a civil or structural engineer in Florida. The laboratory agency, mill, or ready-mix plant shall be paid by the Contractor.
2. Selection of mix proportions shall conform to the applicable requirements of ACI 211.1 and ACI 211.2. Concrete shall comply with ACI 301 and ACI 318, as applicable. Ensure that mix designs will produce concrete suited for proper placement and finishing.
3. Mix designs shall indicate brands, types, and quantities of admixtures included. If fly ash is proposed, it shall be identified as such (for example, “fly ash”), and the mix design shall identify the percentage of cement replacement.
4. If concrete is to be placed by pumping, concrete mixes shall be designed in accordance with the applicable requirements of ACI 304R and ACI 304.2R, and shall include strengths and slumps.

5. Mix designs shall indicate location of each mix within the structure.
 6. Mix designs with replacement of Portland cement by weight with fly ash shall not exceed 20 percent.
 7. Mix design for architectural concrete and formed concrete which will be exposed to the public in the finished work shall include 10 percent minimum replacement of the cement with fly ash along with a plasticizing admixture, conforming with ASTM C1017, to provide a dense and plastic concrete mix which completely fills out the forms and form detail without air holes and rock pockets.
 8. Mix design for mass concrete shall have a percentage of fly ash replacement of cement by weight to reduce the amount of heat generated during heat of hydration.
 9. Mix designs of exterior concrete shall include air entrainment by total volume of concrete as indicated in the Structural Notes and 4 to 6 percent for 1-1/2 inch maximum size coarse aggregate, 5 to 7 percent for 3/4 or 1 inch maximum size coarse aggregate in accordance with ASTM C173/C173M.
 10. Aggregates shall conform to Standard Specifications for Concrete Aggregates ASTM C33.
 11. Calcium Chloride or other materials containing chlorides are corrosive to reinforcing steel and shall not be used as an admixture in post-tensioned concrete.
 12. Concrete Strength: As indicated in Structural Notes. Establish required average strength for concrete on the basis of field experience or trial mixtures, as specified in ACI 301.
 13. Drying Shrinkage of Concrete: Establish required "Drying Shrinkage" for concrete on the basis of field experience or trial mixtures, as specified in ASTM C157 and ASTM C490.
 14. Coordinate mix design with requirements of waterproofing membrane.
- B. Type – A – Concrete : All building and exterior concrete.
1. Normal Weight Concrete:
 - a. Compressive Strength, when tested in accordance with ASTM C39/C39M at 28 days:
 - (1) Refer to structural notes.
 - b. Cement Type: Refer to structural notes.

2.09 MIXING

- A. Concrete shall be ready-mixed batched, mixed, and transported in accordance with ASTM C94/C94M, "Specifications for Ready-Mixed Concrete," unless a higher standard is called for.

1. Plant equipment and facilities shall conform to the “Checklist for Certification of Ready Mixed Concrete Production Facilities” of the National Ready-Mixed Concrete Association.
- B. A delivery ticket is required for each load of concrete and shall show the following information:
1. Number of cubic yards.
 2. The exact amount of cement and fly ash (if allowed); this can be indicated either by weight or quantity.
 3. The amount of mixing water including free moisture in aggregates; this can be indicated either by weight or quantity.
 4. Amount of slump in inches.
 5. Type of cement.
 6. Amount of air entrainment when delivered at job site.
 7. Do aggregates meet ASTM specified – yes or no. Indicate maximum size aggregate.
 8. Amount and brand (or ASTM) of admixture other than air entraining agent (if any) previously accepted in writing by Architect.
- C. Delivery tickets shall be given to the Job Superintendent or Foreman and be delivered to the Architect and Testing Contractor once a week. Note exact location of concrete on job.
- D. Adding Water: If concrete arrives on-site with slump less than suitable for placement, do not add water that exceeds the maximum water-cement ratio or exceeds the maximum permissible slump.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify lines, levels, and dimensions before proceeding with work of this section.

3.02 PREPARATION

- A. Verify that forms are clean and free of rust before applying release agent.
- B. Coordinate placement of embedded items with erection of concrete formwork and placement of form accessories.
- C. Where ne concrete is to be bonded to previously placed concrete, prepare existing surface by cleaning with steel brush and applying bonding agent in accordance with manufacturer’s written instructions.
1. Use epoxy bonding system for bonding to damp surfaces, for structural load-

bearing applications, and where curing under humid conditions is required.

- D. In locations where new concrete is doweled to existing work, drill holes in existing concrete, insert steel dowels and pack solid with non-shrink epoxy grout.
- E. Subgrade Preparation: Provide final check of finish grading before reinforcing is placed and make any required adjustments. Provide ground surfaces at optimum moisture content (as determined by Soils Engineer).

3.03 INSTALLING REINFORCEMENT AND OTHER EMBEDDED ITEMS

- A. Comply with requirements of ACI 301. Clean reinforcement of loose rust and mill scale, and accurately position, support, and secure in place prior to concrete placement or achieve not less than minimum concrete coverage required for protection.
- B. Install welded wire reinforcement in maximum possible lengths, and offset end laps in both directions. Splice laps with tie wire.
- C. Verify that anchors, seats, plates, reinforcement and other items to be cast into concrete are accurately placed, positioned securely, and will not interfere with concrete placement.

3.04 PLACING CONCRETE

- A. Place concrete in accordance with ACI 304R.
- B. Protect underslab vapor retarder during all concrete floor forming and installation. No screed stakes or other penetrations shall be allowed. Take all required precautions to prevent excess moisture from entering the base under the vapor retarder prior to, during, and after installing the concrete slab on grade.
 - 1. Repair underslab vapor retarder damaged during placement of concrete reinforcing. Repair with vapor retarder material; lap over damaged areas minimum 6 inches (150 mm) and seal watertight.
- C. The Soils Engineer shall determine the moisture content of the base material prior to placing the concrete and shall make the final determination as to whether the moisture content of the base material is appropriate for concrete placement.
- D. Notify Architect not less than 24 hours prior to commencement of placement operations.
- E. Maintain records of concrete placement. Record date, location. Quantity, air temperature, and test samples taken.
- F. Ensure reinforcement, inserts, embedded parts, and formed construction joint devices will not be disturbed during concrete placement.
- G. Place concrete continuously between pre-determined expansion, control, and construction joints.
- H. Place floor slabs in checkerboard or saw cut pattern indicated.
- I. Finish floors level and flat, unless otherwise indicated, within the tolerances specified

below.

3.05 SLAB JOINTING

- A. Locate joints as indicated on the Drawings or, if not shown, as directed by Architect in conformance with recommendations of Structural Engineer.
- B. Install joint devices in accordance with manufacturer's written instructions.
- C. Anchor joint fillers and devices to prevent movement during concrete placement.
- D. Isolation Joints: Use preformed joint filler with removable top section for joint sealant, total height equal to thickness of slab, set flush with top of slab.
 - 1. Install wherever necessary to separate slab from other building members, including columns, walls, equipment foundations, footings, stairs, manholes, sumps, and drains.
- E. Saw Cut Contraction Joints: Saw cut joints before concrete begins to cool, within 4 to 12 hours after placing; use 3/16 inch thick blade and cut at least 1 inch deep but not less than one quarter (1/4) the depth of the slab.
- F. Install joint device anchors for expansion joint assemblies specified in Section 07 95 13. Maintain correct position to allow joint cover to be flush with floor and wall finish.
- G. Apply sealants in joint devices in accordance with Section 07 92 00.

3.06 CONCRETE FINISHING

- A. Repair surface defects, including tie holes, immediately after removing formwork.
- B. Coordinate finish with requirements of waterproofing membrane.
- C. Unexposed Form Finish: Rub down or chip off fins or other raised areas 1/4 inch or more in height.
- D. Exposed Form Finish: Rub down or chip off and smooth fins or other raised areas 1/4 inch or more in height. Provide finish as follows:
- E. Concrete Slabs: Finish to requirements of ACI 302.1R, and as follows:
 - 1. Exposed Surfaces: Trowel as described in ACI 302.1R; use steel-reinforced plastic trowel blades instead of steel blades to avoid black-burnish marks; exposed surfaces include surfaces to be stained or dyed and all other exposed slab surfaces.

3.07 CURING AND PROTECTION

- A. Comply with requirements of ACI 308R. Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury.
- B. Maintain concrete with minimal moisture loss at relatively constant temperature for period necessary for hydration of cement and hardening of concrete.

1. Normal concrete: Not less than seven days.

C. Exterior Concrete

1. Refer to Section 32 13 13 – Concrete Paving and Site Elements

3.08 FIELD QUALITY CONTROL

- A. An independent testing agency will perform field quality control tests, as specified in Section 01 43 00 – Quality Assurance and Qualifications.
- B. Provide free access to concrete operations at project site and cooperate with appointed firm.
- C. Submit proposed mix design of each class of concrete to inspection and testing firm for review prior to commencement of concrete operations.
- D. Tests of concrete and concrete materials may be performed at any time to ensure compliance with specified requirements.
- E. Compressive Strength Tests: ASTM C39/C39M, for each test, mold and cure three concrete test cylinders. Obtain test samples for every 100 cubic yards or less of each class of concrete placed.
- F. Take on additional test cylinder during cold weather concreting, cured on job site under same conditions as concrete it represents.
- G. Perform on slump test for each set of test cylinders taken, following procedures of ASTM C143/C143M.

3.09 DEFECTIVE CONCRETE

- A. Test Results: The testing agency shall report test results in writing to Architect and Contractor within 24 hours of test.
- B. Defective Concrete: Concrete not conforming to required lines, details, dimensions, tolerance, visual appearance or specified requirements as determined by the Architect.
- C. Repair or replacement of defective concrete will be determined by the Architect. The cost of additional testing shall be borne by Contractor when defective concrete is identified.
- D. Do not patch, fill, touch-up, repair, or replace exposed concrete except upon express direction of Architect for each individual area.

3.10 PROTECTION

- A. Do not permit traffic over unprotected concrete floor surface until fully cured.

3.11 SCHEDULE- REFER TO DRAWINGS

END OF SECTION 03 30 00

SECTION 03 30 00
CAST-IN-PLACE CONCRETE (BUILDING)

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:

- 1. Cast-in-place concrete, including concrete materials, mixture design, placement procedures, and finishes.

B. Related Requirements:

- 1. Section 01 11 00 "Summary of Work" for all Buy America Build America Act (BABA) requirements.
- 2. Section 031000 "Concrete Forming and Accessories" for form-facing materials, form liners, insulating concrete forms, and waterstops.
- 3. Section 03 20 00 "Concrete Reinforcing" for steel reinforcing bars and welded-wire reinforcement.
- 4. Section 03 33 00 "Architectural Concrete" for general building applications of specially finished formed concrete.
- 5. Section 03 35 43 "Polished Concrete Finishing" for concrete floors scheduled to receive a polished concrete finish.
- 6. Section 03 53 00 "Concrete Topping" for emery- and iron-aggregate concrete floor toppings.
- 7. Section 31 20 00 "Earth Moving" for drainage fill under slabs-on-ground.
- 8. Section 32 13 13 "Concrete Paving" for concrete pavement and walks.
- 9. Section 32 13 16 "Decorative Concrete Paving" for decorative concrete pavement and walks.

1.03 DEFINITIONS

- A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash, slag cement, other pozzolans, and silica fume; materials subject to compliance with requirements.
- B. Water/Cement Ratio (w/cm): The ratio by weight of water to cementitious materials.

1.04 ACTION SUBMITTALS

- A. Product Data: For each of the following.
1. Portland cement.
 2. Fly ash.
 3. Aggregates.
 4. Admixtures:
 - a. Include limitations of use, including restrictions on cementitious materials, supplementary cementitious materials, air entrainment, aggregates, temperature at time of concrete placement, relative humidity at time of concrete placement, curing conditions, and use of other admixtures.
 5. Curing materials.
 - a. Include documentation from color pigment manufacturer, indicating that proposed methods of curing are recommended by color pigment manufacturer.
 6. Joint fillers.
 7. Repair materials.
- B. Design Mixtures: For each concrete mixture, include the following:
1. Mixture identification.
 2. Minimum 28-day compressive strength.
 3. Durability exposure class.
 4. Maximum w/cm.
 5. Calculated equilibrium unit weight, for lightweight concrete.
 6. Slump limit.
 7. Air content.
 8. Nominal maximum aggregate size.
 9. Steel-fiber reinforcement content.
 10. Synthetic micro-fiber content.
 11. Indicate amounts of mixing water to be withheld for later addition at Project site if permitted.

12. Include manufacturer's certification that permeability-reducing admixture is compatible with mix design.
13. Include certification that dosage rate for permeability-reducing admixture matches dosage rate used in performance compliance test.
14. Intended placement method.
15. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

C. Shop Drawings:

1. Construction Joint Layout: Indicate proposed construction joints required to construct the structure.
 - a. Location of construction joints is subject to approval of the Architect.

D. Samples: For vapor retarder .

1.05 INFORMATIONAL SUBMITTALS

A. Material Certificates: For each of the following, signed by manufacturers:

1. Cementitious materials.
2. Admixtures.
3. Curing compounds.
4. Bonding agents.
5. Adhesives.
6. Vapor retarders.
7. Semirigid joint filler.
8. Joint-filler strips.
9. Repair materials.

B. Material Test Reports: For the following, from a qualified testing agency:

1. Portland cement.
2. Fly ash.
3. Aggregates.
4. Admixtures:

- a. Permeability-Reducing Admixture: Include independent test reports, indicating compliance with specified requirements, including dosage rate used in test.

C. Field quality-control reports.

1.06 QUALITY ASSURANCE

A. Laboratory Testing Agency Qualifications: A testing agency qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated and employing an ACI-certified Concrete Quality Control Technical Manager.

- 1. Personnel performing laboratory tests shall be an ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician, Grade I. Testing agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician, Grade II.

B. Field Quality Control Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated.

- 1. Personnel conducting field tests shall be qualified as an ACI Concrete Field Testing Technician, Grade 1, in accordance with ACI CPP 610.1 or an equivalent certification program.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Comply with ASTM C94/C94M and ACI 301.

1.08 FIELD CONDITIONS

A. Cold-Weather Placement: Comply with ACI 301 and ACI 306.1 and as follows.

- 1. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
- 2. When average high and low temperature is expected to fall below 40 deg F for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
- 3. Do not use frozen materials or materials containing ice or snow.
- 4. Do not place concrete in contact with surfaces less than 35 deg F, other than reinforcing steel.
- 5. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.

B. Hot-Weather Placement: Comply with ACI 301 and ACI 305.1, and as follows:

- 1. Maintain concrete temperature at time of discharge to not exceed 95 deg F.

2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

PART 2 - PRODUCTS

2.01 CONCRETE, GENERAL

- A. ACI Publications: Comply with ACI 301 unless modified by requirements in the Contract Documents.

2.02 CONCRETE MATERIALS

A. Source Limitations:

1. Obtain all concrete mixtures from a single ready-mixed concrete manufacturer for entire Project.
2. Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant.
3. Obtain aggregate from single source.
4. Obtain each type of admixture from single source from single manufacturer.

B. Cementitious Materials:

1. Portland Cement: ASTM C150/C150M, Type I/II , gray .
2. Fly Ash: ASTM C618, Class C or F.

C. Normal-Weight Aggregates: ASTM C33/C33M, Class 3M coarse aggregate or better, graded. Provide aggregates from a single source.

1. Alkali-Silica Reaction: Comply with one of the following:

- a. Expansion Result of Aggregate: Not more than 0.04 percent at one-year when tested in accordance with ASTM C1293.
- b. Expansion Results of Aggregate and Cementitious Materials in Combination: Not more than 0.10 percent at an age of 16 days when tested in accordance with ASTM C1567.
- c. Alkali Content in Concrete: Not more than 4 lb./cu. yd. for moderately reactive aggregate or 3 lb./cu. yd. for highly reactive aggregate, when tested in accordance with ASTM C1293 and categorized in accordance with ASTM C1778, based on alkali content being calculated in accordance with ACI 301.

2. Maximum Coarse-Aggregate Size: As indicated .

3. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

- D. Air-Entraining Admixture: ASTM C260/C260M.
- E. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures that do not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride in steel-reinforced concrete.
1. Water-Reducing Admixture: ASTM C494/C494M, Type A.
 2. Retarding Admixture: ASTM C494/C494M, Type B.
 3. Water-Reducing and -Retarding Admixture: ASTM C494/C494M, Type D.
 4. High-Range, Water-Reducing Admixture: ASTM C494/C494M, Type F.
 5. High-Range, Water-Reducing and -Retarding Admixture: ASTM C494/C494M, Type G.
 6. Plasticizing and Retarding Admixture: ASTM C1017/C1017M, Type II.
 7. Set-Accelerating Corrosion-Inhibiting Admixture: Commercially formulated, anodic inhibitor or mixed cathodic and anodic inhibitor; capable of forming a protective barrier and minimizing chloride reactions with steel reinforcement in concrete and complying with ASTM C494/C494M, Type C.
 - a. Manufacturers: Subject to compliance with requirements, undefined:
 - (1) BASF Corporation.
 - (2) Euclid Chemical Company (The); an RPM company.
 - (3) Sika Corporation.
 8. Non-Set-Accelerating Corrosion-Inhibiting Admixture: Commercially formulated, non-set-accelerating, anodic inhibitor or mixed cathodic and anodic inhibitor; capable of forming a protective barrier and minimizing chloride reactions with steel reinforcement in concrete.
 - a. Manufacturers: Subject to compliance with requirements, undefined:
 - (1) BASF Corporation.
 - (2) Sika Corporation.
 9. Permeability-Reducing Admixture: ASTM C494/C494M, Type S, hydrophilic, permeability-reducing crystalline admixture, capable of reducing water absorption of concrete exposed to hydrostatic pressure (PRAH).
 - a. Manufacturers: Subject to compliance with requirements, undefined:
 - (1) AQUAFIN, Inc.

- (2) Kryton International Inc.
- (3) Xypex Chemical Corporation.
- b. Permeability: No leakage when tested in accordance with U.S. Army Corps of Engineers CRC C48 at a hydraulic pressure of 200 psi for 14 days.
- F. Water and Water Used to Make Ice: ASTM C94/C94M, potable or complying with ASTM C1602/C1602M, including all limits listed in Table 2 and the requirements of paragraph 5.4

2.03 CURING MATERIALS

- A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. BASF Corporation.
 - b. Euclid Chemical Company (The); an RPM company.
 - c. Kaufman Products, Inc.
 - d. Sika Corporation.
- B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.
- C. Moisture-Retaining Cover: ASTM C171, polyethylene film burlap-polyethylene sheet.
 - 1. Color:
 - a. Ambient Temperature Below 50 deg F: Black.
 - b. Ambient Temperature between 50 deg F and 85 deg F: Any color.
 - c. Ambient Temperature Above 85 deg F: White.
- D. Curing Paper: Eight-foot- wide paper, consisting of two layers of fibered kraft paper laminated with double coating of asphalt.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Fortifiber Building Systems Group.
- E. Water: Potable or complying with ASTM C1602/C1602M.
- F. Clear, Waterborne, Membrane-Forming, Dissipating Curing Compound: ASTM C309,

Type 1, Class B.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Euclid Chemical Company (The); an RPM company.
 - b. Kaufman Products, Inc.

- G. Clear, Waterborne, Membrane-Forming, Nondissipating Curing Compound: ASTM C309, Type 1, Class B , certified by curing compound manufacturer to not interfere with bonding of floor covering.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. BASF Corporation.
 - b. Euclid Chemical Company (The); an RPM company.
 - c. Kaufman Products, Inc.

- H. Clear, Waterborne, Membrane-Forming, Curing Compound: ASTM C309, Type 1, Class B, 18 to 25 percent solids, nondissipating , certified by curing compound manufacturer to not interfere with bonding of floor covering.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. BASF Corporation.
 - b. Euclid Chemical Company (The); an RPM company.
 - c. Kaufman Products, Inc.

- I. Clear, Solvent-Borne, Membrane-Forming, Curing and Sealing Compound: ASTM C1315, Type 1, Class A.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. BASF Corporation.
 - b. Euclid Chemical Company (The); an RPM company.
 - c. Kaufman Products, Inc.

- J. Clear, Waterborne, Membrane-Forming, Curing and Sealing Compound: ASTM C1315, Type 1, Class A.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Euclid Chemical Company (The); an RPM company.
- b. Kaufman Products, Inc.

2.04 CONCRETE MIXTURES, GENERAL

- A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, in accordance with ACI 301.
 1. Use a qualified testing agency for preparing and reporting proposed mixture designs, based on laboratory trial mixtures.
- B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:
 1. Fly Ash or Other Pozzolans: 20 percent by mass.
 2. Slag Cement: 40 percent by mass.
 3. Silica Fume: 10 percent by mass.
 4. Total of Fly Ash or Other Pozzolans, Slag Cement, and Silica Fume: 50 percent by mass, with fly ash or pozzolans not exceeding 25 percent by mass and silica fume not exceeding 10 percent by mass.
 5. Total of Fly Ash or Other Pozzolans and Silica Fume: 35 percent by mass with fly ash or pozzolans not exceeding 25 percent by mass and silica fume not exceeding 10 percent by mass.
- C. Admixtures: Use admixtures in accordance with manufacturer's written instructions.
 1. Use water-reducing high-range water-reducing or plasticizing admixture in concrete, as required, for placement and workability.
 2. Use water-reducing and -retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
 3. Use water-reducing admixture in pumped concrete, concrete for parking structure slabs, and concrete with a w/cm below 0.50.
 4. Use corrosion-inhibiting admixture in concrete mixtures where indicated.
 5. Use permeability-reducing admixture in concrete mixtures where indicated.
- D. Color Pigment: Add color pigment to concrete mixture in accordance with manufacturer's written instructions and to result in hardened concrete color consistent with approved mockup.

2.05 CONCRETE MIXTURES

- A. Class B : Normal-weight concrete used for foundation walls.

1. Exposure Class: ACI 318 F2 .
 2. Minimum Compressive Strength: As indicated at 28 days.
 3. Maximum w/cm: As Indicated .
 4. Slump Limit: As indicated .
 5. Slump Flow Limit: 22 inches , plus or minus 1.5 inches .
 6. Air Content:
 - a. Exposure Class F1: .
 - b. Exposure Classes F2 and F3: .
 7. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 **<Insert number>** percent by weight of cement.
- B. Class C : Normal-weight concrete used for interior slabs-on-ground.
1. Exposure Class: ACI 318 C2.
 2. Minimum Compressive Strength: As indicated at 28 days.
 3. Maximum w/cm: As indicated .
 4. Minimum Cementitious Materials Content: 540 lb/cu. yd. .
 5. Slump Limit: 5 inches , plus or minus 1 inch 8 inches , plus or minus 1 inch for concrete with verified slump of 3 inches plus or minus 1 inch before adding high-range water-reducing admixture or plasticizing admixture at Project site .
 6. Slump Flow Limit: 22 inches , plus or minus 1.5 inches .
 7. Air Content:
 - a. Do not use an air-entraining admixture or allow total air content to exceed 3 percent for concrete used in trowel-finished floors.
 8. Limit water-soluble, chloride-ion content in hardened concrete to 0.30 percent by weight of cement.
- C. Class D : Normal-weight concrete used for interior suspended slabs.
1. Exposure Class: ACI 318 F0 .
 2. Minimum Compressive Strength: As indicated at 28 days.
 3. Maximum w/cm: 0.50 As indicated .
 4. Minimum Cementitious Materials Content: As determined and required to meet

noted compressive strengths.

5. Slump Limit: As indicated.
6. Slump Flow Limit: 30 inches , plus or minus 2.5 inches .
7. Air Content:
 - a. Do not use an air-entraining admixture or allow total air content to exceed 3 percent for concrete used in trowel-finished floors.
8. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.
9. Steel-Fiber Reinforcement: Add to concrete mixture, in accordance with manufacturer's written instructions, at a rate of 50 lb/cu. yd. .
10. Synthetic Micro-Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than a rate of .
11. Synthetic Macro-Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than a rate of .

D. Class F : Normal-weight concrete used for concrete toppings.

1. Exposure Class: ACI 318 C2.
2. Minimum Compressive Strength: As indicated at 28 days.
3. Minimum Cementitious Materials Content: 540 lb/cu. yd..
4. Slump Limit: 5 inches, plus or minus 1 inch.
5. Air Content:
 - a. Exposure Class F1: .
 - b. Exposure Classes F2 and F3: 6 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch nominal maximum aggregate size 6 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-inch nominal maximum aggregate size 5.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-1/2-inch nominal maximum aggregate size.
6. Limit water-soluble, chloride-ion content in hardened concrete to 0.30 percent by weight of cement.
 - a. Do not use an air-entraining admixture or allow total air content to exceed 3 percent for concrete used in trowel-finished toppings.

E. Class G : Normal-weight concrete used for building frame members.

1. Exposure Class: ACI 318 F0 .
 2. Minimum Compressive Strength: As indicated at 28 days.
 3. Maximum w/cm: As indicated .
 4. Slump Limit: As indicated.
 5. Slump Flow Limit: 30 inches , plus or minus 2.5 inches .
 6. Air Content:
 - a. Exposure Class F1: .
 - b. Exposure Classes F2 and F3: .
 7. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.
- F. Class H : Normal-weight concrete used for building walls.
1. Exposure Class: ACI 318 F2 .
 2. Minimum Compressive Strength: As indicated at 28 days.
 3. Maximum w/cm: As indicated .
 4. Slump Limit: As indicated.
 5. Slump Flow Limit: 30 inches , plus or minus 2.5 inches .
 6. Air Content:
 - a. Exposure Class F1: .
 - b. Exposure Classes F2 and F3: .
 7. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
1. Before placing concrete, verify that installation of concrete forms, accessories, and reinforcement, and embedded items is complete and that required inspections have been performed.
 2. Do not proceed until unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Provide reasonable auxiliary services to accommodate field testing and inspections, acceptable to testing agency, including the following:
 - 1. Daily access to the Work.
 - 2. Incidental labor and facilities necessary to facilitate tests and inspections.
 - 3. Secure space for storage, initial curing, and field curing of test samples, including source of water and continuous electrical power at Project site during site curing period for test samples.
 - 4. Security and protection for test samples and for testing and inspection equipment at Project site.

3.03 INSTALLATION OF EMBEDDED ITEMS

- A. Place and secure anchorage devices and other embedded items required for adjoining Work that is attached to or supported by cast-in-place concrete.
 - 1. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 2. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of ANSI/AISC 303.
 - 3. Install reglets to receive waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.

3.04 JOINTS

- A. Construct joints true to line, with faces perpendicular to surface plane of concrete.
- B. Construction Joints: Coordinate with floor slab pattern and concrete placement sequence.
 - 1. Install so strength and appearance of concrete are not impaired, at locations indicated on Drawings or as approved by Architect.
 - 2. Place joints perpendicular to main reinforcement.
 - a. Continue reinforcement across construction joints unless otherwise indicated.
 - b. Do not continue reinforcement through sides of strip placements of floors and slabs.
 - 3. Form keyed joints as indicated. Embed keys at least 1-1/2 inches into concrete.
 - 4. Locate joints for beams, slabs, joists, and girders at third points of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder

intersection.

5. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
 6. Space vertical joints in walls as indicated on Drawings . Unless otherwise indicated on Drawings, locate vertical joints beside piers integral with walls, near corners, and in concealed locations where possible.
 7. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
 8. Use epoxy-bonding adhesive at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
- C. Control Joints in Slabs-on-Ground: Form weakened-plane control joints, sectioning concrete into areas as indicated. Construct control joints for a depth equal to at least one-fourth of concrete thickness as follows:
1. Grooved Joints: Form control joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch. Repeat grooving of control joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.
 2. Sawed Joints: Form control joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- wide joints into concrete when cutting action does not tear, abrade, or otherwise damage surface and before concrete develops random cracks.
- D. Doweled Joints:
1. Install dowel bars and support assemblies at joints where indicated on Drawings.
 2. Lubricate or asphalt coat one-half of dowel bar length to prevent concrete bonding to one side of joint.

3.05 CONCRETE PLACEMENT

- A. Before placing concrete, verify that installation of formwork, reinforcement, embedded items, and vapor retarder is complete and that required inspections are completed.
1. Immediately prior to concrete placement, inspect vapor retarder for damage and deficient installation, and repair defective areas.
 2. Provide continuous inspection of vapor retarder during concrete placement and make necessary repairs to damaged areas as Work progresses.
- B. Notify Architect and testing and inspection agencies 24 hours prior to commencement of concrete placement.
- C. Do not add water to concrete during delivery, at Project site, or during placement unless approved by Architect in writing, but not to exceed the amount indicated on the concrete

delivery ticket.

1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.
- D. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301, but not to exceed the amount indicated on the concrete delivery ticket.
1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.
- E. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete is placed on concrete that has hardened enough to cause seams or planes of weakness.
1. If a section cannot be placed continuously, provide construction joints as indicated.
 2. Deposit concrete to avoid segregation.
 3. Deposit concrete in horizontal layers of depth not to exceed formwork design pressures and in a manner to avoid inclined construction joints.
 4. Consolidate placed concrete with mechanical vibrating equipment in accordance with ACI 301.
 - a. Do not use vibrators to transport concrete inside forms.
 - b. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches into preceding layer.
 - c. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity.
 - d. At each insertion, limit duration of vibration to time necessary to consolidate concrete, and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.
- F. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.
1. Do not place concrete floors and slabs in a checkerboard sequence.
 2. Consolidate concrete during placement operations, so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
 3. Maintain reinforcement in position on chairs during concrete placement.
 4. Screed slab surfaces with a straightedge and strike off to correct elevations.
 5. Level concrete, cut high areas, and fill low areas.

6. Slope surfaces uniformly to drains where required.
7. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface.
8. Do not further disturb slab surfaces before starting finishing operations.

3.06 FINISHING FORMED SURFACES

A. As-Cast Surface Finishes:

1. ACI 301 Surface Finish SF-1.0: As-cast concrete texture imparted by form-facing material.
 - a. Patch voids larger than 1-1/2 inches wide or 1/2 inch deep.
 - b. Remove projections larger than 1 inch.
 - c. Tie holes do not require patching.
 - d. Surface Tolerance: ACI 117 Class D.
 - e. Apply to concrete surfaces not exposed to public view .
2. ACI 301 Surface Finish SF-2.0: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams.
 - a. Patch voids larger than 3/4 inch wide or 1/2 inch deep.
 - b. Remove projections larger than 1/4 inch.
 - c. Patch tie holes.
 - d. Surface Tolerance: ACI 117 Class B.
 - e. Locations: Apply to concrete surfaces exposed to public view, to receive a rubbed finish, .
3. ACI 301 Surface Finish SF-3.0:
 - a. Patch voids larger than 3/4 inch wide or 1/2 inch deep.
 - b. Remove projections larger than 1/8 inch.
 - c. Patch tie holes.
 - d. Surface Tolerance: ACI 117 Class A.
 - e. Locations: Apply to concrete surfaces exposed to public view, to receive a rubbed finish, .

B. Rubbed Finish: Apply the following to as cast surface finishes where indicated on Drawings:

1. Smooth-Rubbed Finish:

- a. Perform no later than one day after form removal.
- b. Moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture.
- c. If sufficient cement paste cannot be drawn from the concrete by the rubbing process, use a grout made from the same cementitious materials used in the in-place concrete.
- d. Maintain required patterns or variances as shown on Drawings or to match design reference sample .

2. Grout-Cleaned Rubbed Finish:

- a. Clean concrete surfaces after contiguous surfaces are completed and accessible.
- b. Do not clean concrete surfaces as Work progresses.
- c. Mix 1 part portland cement to 1-1/2 parts fine sand, complying with ASTM C144 or ASTM C404, by volume, with sufficient water to produce a mixture with the consistency of thick paint. Add white portland cement in amounts determined by trial patches, so color of dry grout matches adjacent surfaces.
- d. Wet concrete surfaces.
- e. Scrub grout into voids and remove excess grout. When grout whitens, rub surface with clean burlap, and keep surface damp by fog spray for at least 36 hours.
- f. Maintain required patterns or variances as shown on Drawings or to match design reference sample .

3. Cork-Floated Finish:

- a. Mix 1 part portland cement to 1 part fine sand, complying with ASTM C144 or ASTM C404, by volume, with sufficient water to produce a mixture with the consistency of thick paint.
- b. Mix 1 part portland cement and 1 part fine sand with sufficient water to produce a mixture of stiff grout. Add white portland cement in amounts determined by trial patches, so color of dry grout matches adjacent surfaces.
- c. Wet concrete surfaces.

- d. Compress grout into voids by grinding surface.
 - e. In a swirling motion, finish surface with a cork float.
 - f. Maintain required patterns or variances as shown on Drawings or to match design reference sample .
4. Scrubbed Finish: After concrete has achieved a compressive strength of from 1000 to 1500 psi, apply scrubbed finish.
- a. Wet concrete surfaces thoroughly and scrub with stiff fiber or wire brushes, using water freely, until top mortar surface is removed and aggregate is uniformly exposed.
 - b. Rinse scrubbed surfaces with clean water.
 - c. Maintain continuity of finish on each surface or area of Work.
 - d. Remove only enough concrete mortar from surfaces to match design reference sample .
- C. Abrasive-Blast Finish: Apply the following to as-cast surface finishes where indicated on Drawings:
- 1. Perform abrasive blasting after compressive strength of concrete exceeds 2000 psi.
 - 2. Coordinate with formwork removal to ensure that surfaces to be abrasive blasted are treated at the same age.
 - 3. Surface Continuity:
 - a. Perform abrasive-blast finishing as continuous operation, maintaining continuity of finish on each surface or area of Work.
 - b. Maintain required patterns or variances in depths of blast to match design reference sample .
 - 4. Abrasive Blasting:
 - a. Abrasive-blast corners and edges of patterns carefully, using backup boards to maintain uniform corner and edge lines.
 - b. Determine type of nozzle pressure and blasting techniques required to match field sample.
 - c. Depth of Cut: Use an abrasive grit of proper type and gradation to expose aggregate and surrounding matrix surfaces to match field sample, as follows:
 - (1) Brush Texture: Remove cement matrix to dull surface sheen and expose face of fine aggregate, with no significant reveal.

- (2) Light Texture: Expose fine aggregate with occasional exposure of coarse aggregate and uniform color, with maximum reveal of 1/16 inch.
 - (3) Medium Texture: Generally, expose coarse aggregate with slight reveal and with a maximum reveal of 1/4 inch.
 - (4) Heavy Texture: Expose and reveal coarse aggregate to a maximum projection of one-third its diameter, with reveal range of 1/4 to 1/2 inch.
- d. Maintain required patterns or variances in reveal projection to match design reference sample .

3.07 FINISHING FLOORS AND SLABS

- A. Comply with ACI 302.1R recommendations for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.
- B. Trowel and Fine-Broom Finish: Apply a first trowel finish to surfaces indicated on Drawings . While concrete is still plastic, slightly scarify surface with a fine broom perpendicular to main traffic route.
 1. Coordinate required final finish with Architect before application.
 2. Comply with flatness and levelness tolerances for trowel-finished floor surfaces.
- C. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, ramps, and locations indicated on Drawings.
 1. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route.
 2. Coordinate required final finish with Architect before application.

3.08 INSTALLATION OF MISCELLANEOUS CONCRETE ITEMS

- A. Filling In:
 1. Fill in holes and openings left in concrete structures after Work of other trades is in place unless otherwise indicated.
 2. Mix, place, and cure concrete, as specified, to blend with in-place construction.
 3. Provide other miscellaneous concrete filling indicated or required to complete the Work.
- B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.
- C. Equipment Bases and Foundations:

1. Coordinate sizes and locations of concrete bases with actual equipment provided.
 2. Construct concrete bases 10 inches high unless otherwise indicated on Drawings, and extend base not less than 6 inches in each direction beyond the maximum dimensions of supported equipment unless otherwise indicated on Drawings, or unless required for seismic anchor support.
 3. Minimum Compressive Strength: 3000 psi at 28 days.
 4. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
 5. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete substrate.
 6. Prior to pouring concrete, place and secure anchorage devices.
 - a. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - b. Cast anchor-bolt insert into bases.
 - c. Install anchor bolts to elevations required for proper attachment to supported equipment.
- D. Steel Pan Stairs: Provide concrete fill for steel pan stair treads, landings, and associated items.
1. Cast-in inserts and accessories, as shown on Drawings.
 2. Screed, tamp, and trowel finish concrete surfaces.

3.09 CONCRETE CURING

- A. Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.
1. Comply with ACI 301 and ACI 306.1 for cold weather protection during curing.
 2. Comply with ACI 301 and ACI 305.1 for hot-weather protection during curing.
 3. Maintain moisture loss no more than 0.2 lb/sq. ft. x h before and during finishing operations.
- B. Curing Formed Surfaces: Comply with ACI 308.1 as follows:
1. Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces.
 2. Cure concrete containing color pigments in accordance with color pigment manufacturer's instructions.

3. If forms remain during curing period, moist cure after loosening forms.
4. If removing forms before end of curing period, continue curing for remainder of curing period, as follows:
 - a. Continuous Fogging: Maintain standing water on concrete surface until final setting of concrete.
 - b. Continuous Sprinkling: Maintain concrete surface continuously wet.
 - c. Absorptive Cover: Pre-dampen absorptive material before application; apply additional water to absorptive material to maintain concrete surface continuously wet.
 - d. Water-Retention Sheeting Materials: Cover exposed concrete surfaces with sheeting material, taping, or lapping seams.
 - e. Membrane-Forming Curing Compound: Apply uniformly in continuous operation by power spray or roller in accordance with manufacturer's written instructions.
 - (1) Recoat areas subject to heavy rainfall within three hours after initial application.
 - (2) Maintain continuity of coating and repair damage during curing period.

C. Curing Unformed Surfaces: Comply with ACI 308.1 as follows:

1. Begin curing immediately after finishing concrete.
2. Interior Concrete Floors:
 - a. Floors to Receive Floor Coverings Specified in Other Sections: Contractor has option of the following:
 - (1) Absorptive Cover: As soon as concrete has sufficient set to permit application without marring concrete surface, install prewetted absorptive cover over entire area of floor.
 - Lap edges and ends of absorptive cover not less than 12-inches.
 - Maintain absorptive cover water saturated, and in place, for duration of curing period, but not less than seven days.
 - (2) Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive.
 - Immediately repair any holes or tears during curing

period, using cover material and waterproof tape.

- b. Cure for not less than seven days.
- (1) Ponding or Continuous Sprinkling of Water: Maintain concrete surfaces continuously wet for not less than seven days, utilizing one, or a combination of, the following:
- Water.
 - Continuous water-fog spray.
- c. Floors to Receive Penetrating Liquid Floor Treatments: Contractor has option of the following:
- (1) Absorptive Cover: As soon as concrete has sufficient set to permit application without marring concrete surface, install prewetted absorptive cover over entire area of floor.
- Lap edges and ends of absorptive cover not less than 12 inches.
 - Maintain absorptive cover water saturated, and in place, for duration of curing period, but not less than seven days.
- (2) Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive.
- Immediately repair any holes or tears during curing period, using cover material and waterproof tape.
 - Cure for not less than seven days.
- (3) Ponding or Continuous Sprinkling of Water: Maintain concrete surfaces continuously wet for not less than seven days, utilizing one, or a combination of, the following:
- Water.
 - Continuous water-fog spray.
- d. Floors to Receive Polished Finish: Contractor has option of the following:
- (1) Absorptive Cover: As soon as concrete has sufficient set to permit application without marring concrete surface, install prewetted absorptive cover over entire area of floor.
- Lap edges and ends of absorptive cover not less than 12 inches.
 - Maintain absorptive cover water saturated, and in place, for duration of curing period, but not less than seven

days.

- (2) Ponding or Continuous Sprinkling of Water: Maintain concrete surfaces continuously wet for not less than seven days, utilizing one, or a combination of, the following:
 - Water.
 - Continuous water-fog spray.

e. Floors to Receive Chemical Stain:

- (1) As soon as concrete has sufficient set to permit application without marring concrete surface, install curing paper over entire area of floor.
- (2) Install curing paper square to building lines, without wrinkles, and in a single length without end joints.
- (3) Butt sides of curing paper tight; do not overlap sides of curing paper.
- (4) Leave curing paper in place for duration of curing period, but not less than 28 days.

f. Floors to Receive Urethane Flooring:

- (1) As soon as concrete has sufficient set to permit application without marring concrete surface, install prewetted absorptive cover over entire area of floor.
- (2) Rewet absorptive cover, and cover immediately with polyethylene moisture-retaining cover with edges lapped 6 inches and sealed in place.
- (3) Secure polyethylene moisture-retaining cover in place to prohibit air from circulating under polyethylene moisture-retaining cover.
- (4) Leave absorptive cover and polyethylene moisture-retaining cover in place for duration of curing period, but not less than 28 days.

g. Floors to Receive Curing Compound:

- (1) Apply uniformly in continuous operation by power spray or roller in accordance with manufacturer's written instructions.
- (2) Recoat areas subjected to heavy rainfall within three hours after initial application.
- (3) Maintain continuity of coating, and repair damage during curing period.

- (4) Removal: After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer unless manufacturer certifies curing compound does not interfere with bonding of floor covering used on Project.

h. Floors to Receive Curing and Sealing Compound:

- (1) Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller in accordance with manufacturer's written instructions.
- (2) Recoat areas subjected to heavy rainfall within three hours after initial application.
- (3) Repeat process 24 hours later, and apply a second coat. Maintain continuity of coating, and repair damage during curing period.

3.10 TOLERANCES

- A. Conform to ACI 117.

3.11 APPLICATION OF LIQUID FLOOR TREATMENTS

- A. Penetrating Liquid Floor Treatment: Prepare, apply, and finish penetrating liquid floor treatment in accordance with manufacturer's written instructions.
1. Remove curing compounds, sealers, oil, dirt, laitance, and other contaminants and complete surface repairs.
 2. Do not apply to concrete that is less than seven days' old.
 3. Apply liquid until surface is saturated, scrubbing into surface until a gel forms; rewet; and repeat brooming or scrubbing.
 4. Rinse with water; remove excess material until surface is dry.
 5. Apply a second coat in a similar manner if surface is rough or porous.
- B. Sealing Coat: Uniformly apply a continuous sealing coat of curing and sealing compound to hardened concrete by power spray or roller in accordance with manufacturer's written instructions.

3.12 JOINT FILLING

- A. Prepare, clean, and install joint filler in accordance with manufacturer's written instructions.
1. Defer joint filling until concrete has aged at least one month(s).
 2. Do not fill joints until construction traffic has permanently ceased.

- B. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joints clean and dry.
- C. Install semirigid joint filler full depth in saw-cut joints and at least 2 inches deep in formed joints.
- D. Overfill joint, and trim joint filler flush with top of joint after hardening.

3.13 CONCRETE SURFACE REPAIRS

- A. Defective Concrete:
 - 1. Repair and patch defective areas when approved by Architect.
 - 2. Remove and replace concrete that cannot be repaired and patched to Architect's approval.
- B. Patching Mortar: Mix dry-pack patching mortar, consisting of 1 part portland cement to 2-1/2 parts fine aggregate passing a No. 16 sieve, using only enough water for handling and placing.
- C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.
 - 1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch in any dimension to solid concrete.
 - a. Limit cut depth to 3/4 inch.
 - b. Make edges of cuts perpendicular to concrete surface.
 - c. Clean, dampen with water, and brush-coat holes and voids with bonding agent.
 - d. Fill and compact with patching mortar before bonding agent has dried.
 - e. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.
 - 2. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement, so that, when dry, patching mortar matches surrounding color.
 - a. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching.
 - b. Compact mortar in place and strike off slightly higher than surrounding surface.
 - 3. Repair defects on concealed formed surfaces that will affect concrete's durability and structural performance as determined by Architect.

D. Repairing Unformed Surfaces:

1. Test unformed surfaces, such as floors and slabs, for finish, and verify surface tolerances specified for each surface.
 - a. Correct low and high areas.
 - b. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.
2. Repair finished surfaces containing surface defects, including spalls, popouts, honeycombs, rock pockets, crazing, and cracks in excess of 0.01 inch wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
3. After concrete has cured at least 14 days, correct high areas by grinding.
4. Correct localized low areas during, or immediately after, completing surface-finishing operations by cutting out low areas and replacing with patching mortar.
 - a. Finish repaired areas to blend into adjacent concrete.
5. Correct other low areas scheduled to receive floor coverings with a repair underlayment.
 - a. Prepare, mix, and apply repair underlayment and primer in accordance with manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
 - b. Feather edges to match adjacent floor elevations.
6. Correct other low areas scheduled to remain exposed with repair topping.
 - a. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch to match adjacent floor elevations.
 - b. Prepare, mix, and apply repair topping and primer in accordance with manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
7. Repair defective areas, except random cracks and single holes 1 inch or less in diameter, by cutting out and replacing with fresh concrete.
 - a. Remove defective areas with clean, square cuts, and expose steel reinforcement with at least a 3/4-inch clearance all around.
 - b. Dampen concrete surfaces in contact with patching concrete and apply bonding agent.
 - c. Mix patching concrete of same materials and mixture as original concrete, except without coarse aggregate.

- d. Place, compact, and finish to blend with adjacent finished concrete.
 - e. Cure in same manner as adjacent concrete.
8. Repair random cracks and single holes 1 inch or less in diameter with patching mortar.
- a. Groove top of cracks and cut out holes to sound concrete, and clean off dust, dirt, and loose particles.
 - b. Dampen cleaned concrete surfaces and apply bonding agent.
 - c. Place patching mortar before bonding agent has dried.
 - d. Compact patching mortar and finish to match adjacent concrete.
 - e. Keep patched area continuously moist for at least 72 hours.
- E. Perform structural repairs of concrete, subject to Architect's approval, using epoxy adhesive and patching mortar.
- F. Repair materials and installation not specified above may be used, subject to Architect's approval.

3.14 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a special inspector to perform field tests and inspections and prepare testing and inspection reports.
- B. Testing Agency: Engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports.
- 1. Testing agency shall be responsible for providing curing container for composite samples on Site and verifying that field-cured composite samples are cured in accordance with ASTM C31/C31M.
 - 2. Testing agency shall immediately report to Architect, Contractor, and concrete manufacturer any failure of Work to comply with Contract Documents.
 - 3. Testing agency shall report results of tests and inspections, in writing, to Owner, Architect, Contractor, and concrete manufacturer within 48 hours of inspections and tests.
 - a. Test reports shall include reporting requirements of ASTM C31/C31M, ASTM C39/C39M, and ACI 301, including the following as applicable to each test and inspection:
 - (1) Project name.
 - (2) Name of testing agency.
 - (3) Names and certification numbers of field and laboratory

technicians performing inspections and testing.

- (4) Name of concrete manufacturer.
 - (5) Date and time of inspection, sampling, and field testing.
 - (6) Date and time of concrete placement.
 - (7) Location in Work of concrete represented by samples.
 - (8) Date and time sample was obtained.
 - (9) Truck and batch ticket numbers.
 - (10) Design compressive strength at 28 days.
 - (11) Concrete mixture designation, proportions, and materials.
 - (12) Field test results.
 - (13) Information on storage and curing of samples before testing, including curing method and maximum and minimum temperatures during initial curing period.
 - (14) Type of fracture and compressive break strengths at seven days and 28 days.
- C. Batch Tickets: For each load delivered, submit three copies of batch delivery ticket to testing agency, indicating quantity, mix identification, admixtures, design strength, aggregate size, design air content, design slump at time of batching, and amount of water that can be added at Project site.
- D. Inspections:
1. Headed bolts and studs.
 2. Verification of use of required design mixture.
 3. Concrete placement, including conveying and depositing.
 4. Curing procedures and maintenance of curing temperature.
 5. Verification of concrete strength before removal of shores and forms from beams and slabs.
 6. Batch Plant Inspections: On a random basis, as determined by Architect.
- E. Concrete Tests: Testing of composite samples of fresh concrete obtained in accordance with ASTM C 172/C 172M shall be performed in accordance with the following requirements:
1. Testing Frequency: Obtain one composite sample for each day's pour of each

concrete mixture exceeding 5 cu. yd., but less than 25 cu. yd., plus one set for each additional 50 cu. yd. or fraction thereof.

- a. When frequency of testing provides fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
2. Slump: ASTM C143/C143M:
 - a. One test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture.
 - b. Perform additional tests when concrete consistency appears to change.
 3. Slump Flow: ASTM C1611/C1611M:
 - a. One test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture.
 - b. Perform additional tests when concrete consistency appears to change.
 4. Air Content: ASTM C231/C231M pressure method, for normal-weight concrete;
 - a. One test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
 5. Concrete Temperature: ASTM C1064/C1064M:
 - a. One test hourly when air temperature is 40 deg F and below or 80 deg F and above, and one test for each composite sample.
 6. Unit Weight: ASTM C567/C567M fresh unit weight of structural lightweight concrete.
 - a. One test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
 7. Compression Test Specimens: ASTM C31/C31M:
 - a. Cast and laboratory cure two sets of three 6-inch by 12-inch or 4-inch by 8-inch cylinder specimens for each composite sample.
 - b. Cast, initial cure, and field cure two sets of three standard cylinder specimens for each composite sample.
 8. Compressive-Strength Tests: ASTM C39/C39M.
 - a. Test one set of two laboratory-cured specimens at seven days and one set of two specimens at 28 days.
 - b. Test one set of two field-cured specimens at seven days and one set of

two specimens at 28 days.

- c. A compressive-strength test shall be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.
9. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor shall evaluate operations and provide corrective procedures for protecting and curing in-place concrete.
 10. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength, and no compressive-strength test value falls below specified compressive strength by more than 500 psi if specified compressive strength is 5000 psi, or no compressive strength test value is less than 10 percent of specified compressive strength if specified compressive strength is greater than 5000 psi.
 11. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.
 12. Additional Tests:
 - a. Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect.
 - b. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C42/C42M or by other methods as directed by Architect.
 - (1) Acceptance criteria for concrete strength shall be in accordance with ACI 301 section 1.6.6.3.
 13. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
 14. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.
- F. Measure floor and slab flatness and levelness in accordance with ASTM E1155 within 48 hours of completion of floor finishing and promptly report test results to Architect.

3.15 PROTECTION

- A. Protect concrete surfaces as follows:
 1. Protect from petroleum stains.

2. Diaper hydraulic equipment used over concrete surfaces.
3. Prohibit vehicles from interior concrete slabs.
4. Prohibit use of pipe-cutting machinery over concrete surfaces.
5. Prohibit placement of steel items on concrete surfaces.
6. Prohibit use of acids or acidic detergents over concrete surfaces.
7. Protect liquid floor treatment from damage and wear during the remainder of construction period. Use protective methods and materials, including temporary covering, recommended in writing by liquid floor treatments installer.
8. Protect concrete surfaces scheduled to receive surface hardener or polished concrete finish using Floor Slab Protective Covering.

END OF SECTION 03 30 00

SECTION 03 35 43
POLISHED CONCRETE FINISHING

PART 1 - GENERAL

1.01 REQUIREMENTS

- A. Section includes: products and procedures for bonded abrasive polished concrete floors using multi-step wet/dry mechanical process, and accessories indicated, specified, or required to complete polishing.

1.02 DEFINITIONS

- A. Terminology: As defined by Concrete Polishing Council (CPC) glossary.
- B. Polished Concrete: The act of changing a concrete floor surface, with or without surface exposure of aggregate, to achieve a specified level of appearance.
- C. Bonded Abrasive Polished Concrete: The multi-step operation of mechanically grinding, honing, and polishing a concrete floor surface with bonded abrasives to cut a concrete floor surface and to refine each cut to the maximum potential to achieve a specified level of appearance as defined by the CPC.

1.03 SUBMITTALS

- A. Product Data: Manufacturer's technical literature for each product indicated, specified, or required. Include manufacturer's technical data, application instructions, and recommendations.
- B. Installer Qualifications: Data for company, principal personnel, experience, and training specified in Quality Assurance.
- C. Maintenance Data: For inclusion in maintenance manual required by Division 01.
 - 1. Include instructions for maintenance of installed work, including methods and frequency recommended for maintaining optimum condition under anticipated use.
 - 2. Include precautions against cleaning products and methods which may be detrimental to finishes and performance.

1.04 QUALITY ASSURANCE

- A. Polisher Qualifications:
 - 1. Experience: Company that has successfully completed five projects similar in design, products, and extent to scope of this Project; with a record of successful in-service performance; and with sufficient production capability, facilities, and personnel to produce specified work.
 - 2. Supervision: Maintain a competent supervisor who is at Project during times specified work is in progress, and is currently certified as Craftsman - Level I or

higher by CPAA, CPC Craftsman, or equivalent.

3. Manufacturer Qualification: Approved by manufacturer to apply liquid applied products.
- B. Reference Standards: Comply with provisions of the following, unless otherwise indicated or specified:
1. ASME B46.1-2019, Surface Texture (Surface Roughness, Waviness, and Lay)
 2. ASTM C1895-20 Standard Test Method for Determination of Mohs Scratch Hardness Tests
 3. ASTM E1155-20 Standard Test Method for Determining FF Floor Flatness and FL Floor Levelness Numbers
 4. A21 – Best Practices for Measuring Substrate Flatness for Floor Covering Installations
 5. ASTM D5767-18 Standard Test Method for Instrumental Measurement of Distinctness of Image (DOI) Gloss of Coated Surfaces
- C. Field Mock-up: Before performing work of this Section, provide following field mock-up to verify selections made under submittals and to demonstrate aesthetic effects of polishing. Approval does not constitute approval of deviations from Contract Documents, unless Architect specifically approves deviations in writing.
1. Form, reinforce, and cast concrete slab for 5 foot square field mock-up.
 2. Concrete shall be same mix design as scheduled for Project.
 3. Placement and finishing work shall be performed by same personnel as will place and finish concrete for Project.
 4. Mock-up shall be representative of work to be expected.
 5. Perform grinding, honing, and polishing work as scheduled for Project using same personnel as will perform work for Project.
 6. Approval is for following aesthetic qualities:
 - a. Compliance with approved submittals.
 - b. Compliance with specified aggregate exposure class.
 - c. Compliance with specified appearance level.
 7. Obtain Architect's approval before starting work on Project.
 8. Protect and maintain approved field mock-ups during construction in an undisturbed condition as a standard for judging completed work.

D. Pre-Installation of Concrete Conference: Prior to placing concrete for areas scheduled for polishing, conduct conference at Project to comply with requirements of applicable Division 01 Sections.

1. Required Attendees:
 - a. Owner.
 - b. Engineer (CEI)
 - c. Architect.
 - d. Contractor, including supervisor.
 - e. Concrete producer.
 - f. Concrete finisher, including supervisor.
 - g. Concrete polisher, including supervisor.
 - h. Technical representative of liquid applied product manufacturers.
2. Minimum Agenda: Polisher shall demonstrate understanding of work required by reviewing and discussing procedures for, but not limited to, following:
 - a. Tour field mock-up and representative areas of required work, discuss and evaluate for compliance with Contract Documents, including substrate conditions, surface preparations, sequence of procedures, and other preparatory work performed by other installers.
 - b. Review Contract Document requirements.
 - c. Review approved submittals and field mock-up.
 - d. Review procedures, including, but not limited to:
 - (1) Specific mix design.
 - (2) Specified curing methods/procedures.
 - (3) Projected 3, 14, and 28 day compressive strength test for finished floor and project phasing.
 - (4) Protection of concrete substrate during construction and prior to polishing process.
 - (5) Project phasing and scheduling for each step of grinding, honing and polishing operations including, but not limited to: Quality of qualified personnel committed to project, Quality and size of grinders committed to project, and proper disposal of concrete slurry and/or concrete dust.

- (6) Details of each step of grinding, honing, and polishing operations including but not limited to: Application of liquid applied products and protecting polished concrete floors after polishing work is complete.
3. Reports: Record discussions, including decisions and agreements reached, and furnish copy of record to each party attending.

1.05 FIELD CONDITIONS

- A. Damage and Stain Prevention: It is the responsibility of others to prevent damage and staining of concrete surfaces to be polished.
 1. Prohibit use of markers, spray paint, and soapstone.
 2. Prohibit improper application of liquid membrane film forming curing compounds.
 3. Prohibit vehicle parking over concrete surfaces.
 4. Prohibit pipe-cutting operations over concrete surfaces.
 5. Prohibit storage of any items over concrete surfaces for not less than 28 days after concrete placement.
 6. Prohibit ferrous metals storage over concrete surfaces.
 7. Protect from petroleum, oil, hydraulic fluid, or other liquid dripping from equipment working over concrete surfaces.
 8. Protect from acids and acidic detergents contacting concrete surfaces.
 9. Protect from painting activities over concrete surfaces.
- B. Environmental Limitations: Comply with manufacturer's written instructions for substrate temperature, ambient temperature, moisture, ventilation, and other conditions affecting liquid applied product application.

PART 2 - PRODUCTS

2.01 LIQUID APPLIED PRODUCTS

- A. Liquid Densifier: An aqueous solution of silicon dioxide dissolved in one of the following hydroxides that penetrates into the concrete surface and reacts with the calcium hydroxide to provide a permanent chemical reaction that hardens and densifies the wear surface of the cementitious portion of the concrete.
 1. Sodium Silicate
 2. Potassium Silicate
 3. Lithium Silicate

4. Alkali solution of Colloidal Silicates or Silica

2.02 ACCESSORIES

- A. Repair Material: A product that is designed to repair cracks and surface imperfections. The specified material must have sufficient bonding capabilities to adhere after the polishing to the concrete surface and provide abrasion resistance equal to or greater than the surrounding concrete substrate.
- B. Grout Material: A thin mortar used for filling spaces. Acceptable products shall be:
 - 1. Epoxy, urethane, polyurea, or polyaspartic resins.
 - 2. Latex or acrylic binders mixed with cement dust from previous grinding steps.
 - 3. Silicate binders mixed with cement dust from previous grinding steps.

2.03 POLISHING EQUIPMENT

- A. Field Grinding and Polishing Equipment:
 - 1. A multiple head, counter rotating, walk behind or ride on machine, of various size and weights, with diamond tooling affixed to the head for the purpose of grinding concrete. Excludes janitorial maintenance equipment.
 - 2. If dry grinding, honing, or polishing, use dust extraction equipment with flow rate suitable for dust generated, with squeegee attachments to meet OSHA requirements.
 - 3. If wet grinding, honing, or polishing, use slurry extraction equipment suitable for slurry removal and containment prior to proper disposal.
- B. Edge Grinding and Polishing Equipment: Hand-held or walk-behind machines which produces the same results, without noticeable differences, as field grinding and polishing equipment.
- C. Burnishing Equipment: High speed walk-behind or ride-on machines capable of generating 1000 to 2000 revolutions per minute and with sufficient head pressure of not less than 20 pounds to raise floor temperature by 20 degrees F.
- D. Diamond Tooling: Abrasive tools that contain industrial grade diamonds within a bonded matrix (such as metallic, resinous, ceramic, etc) that are attached to rotating heads to refine the concrete substrate.
 - 1. Bonded Abrasive: Abrasive medium that is held within a bonding that erodes away to expose new abrasive medium as it is used.
 - 2. Metal Bond Tooling: Diamond tooling that contains industrial grade diamonds with a metallic bonded matrix that is attached to rotating heads to refine the concrete substrate. These tools are available in levels of soft, medium, and hard metallic matrices that are matched with contrasting concrete substrates (i.e. hard matrix/soft concrete, medium matrix/medium concrete, soft matrix/hard concrete)

and are typically used in the grinding and early honing stages of the polishing process.

3. Resin Bond Tooling: Diamond tooling that contains industrial grade diamonds within a resinous bonded matrix (poly-phenolic, ester-phenolic, and thermoplastic-phenolic) that is attached to rotating heads to refine the concrete substrate. Resin bond tooling does not have the soft/medium/hard characteristics of metal bond tooling and are typically used for the later honing and polishing stages of the polishing process.
4. Hybrid Tooling: Diamond tooling that combines metal bond and resin bond that has the characteristics of both types of tooling. These types of tools are typically used as either transitional tooling from metal bond tools to resin bond tools or as a first cut tool on smooth concrete surfaces.
5. Transitional Tooling: Diamond tooling that is used to refine the scratch pattern of metal bond tooling prior to the application of resin bond tooling in an effort to extend the life of resin bond tooling and to create a better foundation for the polishing process.
6. Abrasive Pad: An abrasive pad, resembling a typical floor maintenance burnishing pad that has the capability of refining the concrete surface on a microscopic level that may or may not contain industrial grade diamonds. These pads are typically used for the maintenance and/or restoration of previously installed polished concrete flooring.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Acceptance of Surfaces and Conditions:
 1. Examine substrates to be polished for compliance with requirements and other conditions affecting performance.
 - a. Concrete finished floor flatness.
 - (1) Polished Concrete: level and ground flat
 - (2) Sealed Concrete: level
 - b. Concrete curing methods as indicated by structural plans.
 - c. Concrete compressive strength as indicated by structural plans.
- B. Proceed only when unsatisfactory conditions have been corrected in a manner complying with Contract Documents.
- C. Starting work within a particular area will be construed as acceptance of surface conditions.

3.02 PREPARATION

A. Cleaning New Concrete Surfaces:

1. Prepare and clean concrete surfaces.
2. Provide sound concrete surfaces free of laitance, glaze, efflorescence, curing compounds, form-release agents, dust, dirt, grease, oil, paint splatter, and other contaminants incompatible with liquid applied products and polishing.

3.03 POLISHING CONCRETE FLOORS

A. Perform all polishing procedures to ensure a consistent visual appearance from wall to wall.

B. Initial Grinding:

1. Use grinding equipment with metal or semi-metal bonded tooling.
2. Begin grinding in one direction using sufficient size equipment and diamond tooling to meet specified aggregate exposure class.
3. Make sequential passes with each pass perpendicular to previous pass using finer grit tool with each pass, up to 100 grit metal bonded tooling.

C. Achieve maximum refinement with each pass before proceeding to finer grit tools.

1. Clean floor thoroughly after each pass using dust extraction equipment properly fitted with squeegee attachment or walk behind auto scrubber suitable to remove all visible loose debris and dust.
2. Continue grinding until aggregate surface exposure matches approved field mock-up.

D. Treating Surface Imperfections:

1. Mix patching compound or grout material with dust created by grinding operations, manufacturer's tint, or sand to match color of adjacent concrete surfaces.
2. Fill surface imperfections including, but not limited to, holes, surface damage, small and micro cracks, air holes, pop-outs, and voids with grout to eliminate micro pitting in finished work.
3. Work compound and treatment until color differences between concrete surface and filled surface imperfections, compared to mockup, are not reasonably noticeable when viewed from 20 feet away under lighting conditions that will be present after construction.

E. Liquid Densifier Application: Apply undiluted to point of rejection, remove excess liquid, and allow curing according to manufacturer's instructions.

F. Grout Grinding:

1. Use grinding equipment and appropriate grit and bond diamond tooling.
2. Apply grout, forced into the pore structure of the concrete substrate, to fill surface imperfections.
3. Clean floor thoroughly after each pass using dust extraction equipment properly fitted with squeegee attachment or walk behind auto scrubber suitable to remove all visible loose debris and dust.

G. Honing:

1. Use grinding equipment with hybrid or resin bonded tooling.
2. Hone concrete in one direction starting with 100 grit tooling and make as many sequential passes as required to remove scratches, each pass perpendicular to previous pass, up to 400 grit tooling reaching maximum refinement with each pass before proceeding to finer grit tooling.
3. Clean floor thoroughly after each pass using dust extraction equipment properly fitted with squeegee attachment or walk behind auto scrubber suitable to remove all visible loose debris and dust.

H. Polishing:

1. Use polishing equipment with resin-bonded tooling.
2. Begin polishing in one direction starting with 800 grit tooling.
3. Make sequential passes with each pass perpendicular to previous pass using finer grit tooling with each pass until the specified level of appearance has been achieved.
4. Achieve maximum refinement with each pass before proceeding to finer grit pads.
5. Clean floor thoroughly after each pass using dust extraction equipment properly fitted with squeegee attachment or walk behind auto scrubber suitable to remove all visible loose debris and dust.
6. Stain Protection: Uniformly apply and remove excessive liquid according to manufacturer's instructions. Final film thickness should be less than .05 mils after cure.
7. Final Polish: Using burnishing equipment and finest grit abrasive pads, burnish to uniform reflective sheen matching approved field mock-up.

I. Final Polished Concrete Floor Finish:

1. Aggregate Exposure Class C – Coarse Aggregate: Surface exposure of 80 to 90% coarse aggregate and 10 to 20% cement fines and fine aggregate based on visual observation of the overall area of the polished floor.

2. Appearance Level 3 – Polished:
 - a. Procedure: Recommended not less than 4 steps with full refinement of each diamond tool with one application of densifier.
 - b. Measurement: Determine the Image Clarity Value, 100%, and the Haze Index:
 - (1) Image Clarity Value, 100%: An average value of 40 to 69 measured in accordance with ASTM D5767 prior to the application of sealers.
 - (2) Haze Index: An average value less than 10 measured in accordance with ASTM D4039 prior to the application of sealers.
 - (3) The minimum number of tests distributed across the polished surface should be three, for areas up to 1000 SF and one additional test for each 1000 SF or fraction thereof. This applies to both the Image Clarity Value and Haze Index.

3.04 ROTECTION

- A. Protect floors for duration of construction.

END OF SECTION 03 35 43

SECTION 03 47 13
TILT-UP CONCRETE

PART 1 - GENERAL RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.01 SUMMARY

- A. Section includes load-bearing, tilt-up concrete, including the following:
 - 1. Monolithic panels.
- B. Related Requirements:
 - 1. Section 01 11 00 "Summary of Work" for all Buy America Build America Act (BABA) requirements.
 - 2. Section 07 62 00 "Sheet Metal Flashing and Trim" for flashing receivers and reglets.

1.02 DEFINITIONS

- A. Face-down Surface: Concealed surface of as-cast, tilt-up panel formed against the casting slab.
- B. Face-up Surface: Exposed upper surface of as-cast, tilt-up panel.
- C. Reveal: Projection of the coarse aggregate from the matrix after exposure.

1.03 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site .
 - 1. Before submitting design mixes, review concrete design mixture and examine procedures for ensuring quality of concrete materials. Require representatives of each entity directly concerned with tilt-up concrete to attend, including the following:
 - a. Contractor's superintendent.
 - b. Independent testing agency responsible for concrete design mixtures.
 - c. Ready-mix concrete manufacturer.
 - d. Tilt-up concrete Subcontractor.
 - 2. Review special inspection procedures; testing and inspecting agency procedures for field quality control; tilt-up concrete finishes and finishing; cold- and hot-weather concreting procedures; curing procedures; casting-slab construction, flatness and levelness, finish, and joint requirements; steel reinforcement

installation; hoisting and erection plans; measurement of fabrication and erection tolerances; tilt-up concrete repair procedures; and tilt-up concrete protection.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Design Mixtures: For each concrete mixture. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
- C. Shop Drawings: Detail fabrication and installation of tilt-up concrete units. Indicate panel locations, plans, elevations, dimensions, shapes, cross sections, and details of steel embedments. Match panel identification designations on Shop Drawings with those on Contract Drawings.
 - 1. Include steel reinforcement, detailing fabrication, bending, and placing. Include material, grade, bar schedules, stirrup spacing, bent-bar diagrams, arrangement, and supports of concrete reinforcement.
 - 2. Include additional steel reinforcement to resist hoisting and erection stresses.
 - 3. Include locations and details of hoisting points and lifting devices for handling and erection.
 - 4. Include engineering analysis data of additional steel reinforcement and hoisting and erection details, signed and sealed by the qualified professional engineer responsible for their preparation.
 - 5. Indicate welded connections by AWS standard symbols. Detail cast-in inserts, connections, and joints, including accessories.
 - 6. Include layout of wythe connectors for sandwich panels.

1.05 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer manufacturer .
- B. Material Certificates: For each of the following, signed by manufacturers:
 - 1. Cementitious materials.
 - 2. Admixtures.
 - 3. Steel reinforcement and accessories.
 - 4. Bond breakers.
 - 5. Curing compounds.
 - 6. Inserts and embedments.

7. Sandwich-panel insulation and wythe connectors.
- C. Material Test Reports: For the following, from a qualified testing agency:
1. Aggregates. Include service record data indicating absence of deleterious expansion of concrete due to alkali aggregate reactivity.

1.06 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.
1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."
- B. Installer Qualifications: A qualified installer who employs a supervisor on Project who is an ACI-certified Tilt-up Supervisor.
- C. Testing Agency Qualifications: An independent agency, qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.
1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade I, according to ACI CP-1 or an equivalent certification program.
 2. Personnel performing laboratory tests shall be an ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician, Grade I. Testing agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician, Grade II.
- D. Welding Qualifications: Qualify procedures and personnel according to the following:
1. AWS D1.1/D1.1M.
 2. AWS D1.4/D1.4M.
- E. Mockups: Cast and erect tilt-up concrete panel mockups to demonstrate typical reveals, surface finishes, texture, color, and standard of workmanship.
1. Build mockup panels in the location and of the size indicated or, if not indicated, as directed by Architect.
 2. In presence of Architect, damage part of an exposed surface for each finish, color, and texture required, and demonstrate materials and techniques proposed for repairs to match adjacent undamaged surfaces.
 3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

PART 2 - PRODUCTS

2.01 TILT-UP CONCRETE

- A. Comply with ACI 301, unless modified by requirements in the Contract Documents.

2.02 FORMS AND ACCESSORIES

- A. Forms: Metal, dressed lumber, or other approved materials that are nonreactive with concrete and that will provide continuous, true, and smooth concrete surfaces.
- B. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch.
- C. Form Liners: Units of face design, texture, arrangement, and configuration indicated. Furnish with manufacturer's recommended liquid-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent surface treatments of concrete.
- D. Reveal Strips: Metal, PVC, rubber, straight dressed wood, or plywood; with sides kerfed.
- E. Sealer: Penetrating, clear, polyurethane wood form sealer formulated to reduce absorption of bleedwater and prevent migration of set-retarding chemicals from wood or plywood.

2.03 STEEL REINFORCEMENT

- A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.
- B. Bar Supports: Manufactured according to CRSI's "Manual of Standard Practice" of plastic or CRSI Class 1 plastic-protected steel wire or Class 2 stainless-steel wire.

2.04 CONCRETE MATERIALS

- A. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from single source, and obtain admixtures from single source from single manufacturer.
- B. Cementitious Material:
 - 1. Portland Cement: ASTM C 150/C 150M, Type I/II , gray .
- C. Coarse Aggregate: ASTM C 33/C 33M, coarse aggregate or better, graded. Provide aggregates from single source.
 - 1. Maximum Coarse-Aggregate Size: 1 inch nominal.
- D. Fine Aggregate: ASTM C 33/C 33M , manufactured or natural sand, from same source for Project, free of materials with deleterious reactivity to alkali in cement.
- E. Air-Entraining Admixture: ASTM C 260/C 260M.
- F. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures and that do not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.

1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
 2. Retarding Admixture: ASTM C 494/C 494M, Type B.
 3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
 4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
 5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
 6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.
- G. Water: ASTM C 94/C 94M and potable.

2.05 BOND BREAKERS

- A. Waterborne, Chemically Reactive Bond Breaker: Penetrating polymerized emulsion containing no oils, waxes, paraffins, or silicones, and compatible with casting-slab curing compound.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Nox-Crete Products Group.
 - b. SpecChem, LLC.
 - c. Vexcon Chemicals Inc.
- B. Waterborne, Membrane-Forming Bond Breaker: Dissipating polymerized emulsion containing no oils, waxes, paraffins, or silicones, and compatible with casting-slab curing compound.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Dayton Superior.
 - b. Vexcon Chemicals Inc.

2.06 CURING MATERIALS

- A. Evaporation Retarder: Waterborne, monomolecular film forming; manufactured for application to fresh concrete.
- B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.
- C. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

- D. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B.

2.07 CONNECTION MATERIALS

- A. Loose Hardware: Comply with Section 055000 "Metal Fabrications" for materials for securing tilt-up concrete panels together and to supporting and adjacent construction.
- B. Carbon-Steel Shapes and Plates: ASTM A 36/A 36M.
- C. Carbon-Steel Bolts and Studs: ASTM A 307, Grade A; carbon-steel, hex-head bolts and studs; carbon-steel nuts; and flat, unhardened steel washers.
- D. Unheaded Carbon-Steel Rods and Nuts: ASTM A 36/A 36M, threaded rods with ASTM A 563, nuts.
- E. Welded Headed Studs: AWS D1.1/D1.1M, Type B headed studs, and cold-finished, carbon-steel bars.
- F. Low-Alloy-Steel Reinforcing Bars: ASTM A 706/A 706M, deformed.
- G. Chord Bar Sleeves: Tubular sheathing, plastic or moisture-resistance-treated cardboard.
- H. Welding Electrodes: Comply with AWS standards.
- I. Hot-Dip Galvanized Finish: Apply zinc coating to steel connections by hot-dip process, complying with ASTM A 123/A 123M or ASTM A 153/A 153M as applicable.
 - 1. Zinc Repair Paint: SSPC-Paint 20.
- J. Shop-Primed Finish: Prepare surfaces of steel connections, except those surfaces to be embedded in concrete, according to requirements in SSPC-SP 3, and shop-apply primer according to SSPC-PA 1.
 - 1. Primer: MPI#76.

2.08 LIFTING INSERTS AND ACCESSORIES

- A. Furnish inserts, dowels, bolts, nuts, washers, and other items to be cast in panels for tilting and lifting.
 - 1. Manufacture inserts with feet of plastic, galvanized-steel wire, plastic-tipped steel wire, or stainless-steel-tipped steel wire.
- B. Furnish brace anchors and other accessories to be cast in panels and in casting slab for attaching bracing.
 - 1. Manufacture wall brace anchors and accessories with feet of galvanized-steel wire, plastic-tipped steel wire, or stainless-steel-tipped steel wire.
 - 2. Manufacture floor brace anchors that do not penetrate vapor retarder under slab-on-grade.

2.09 BEARING PADS

- A. Elastomeric Pads: AASHTO M 251, plain, vulcanized, 100 percent polychloroprene (neoprene) elastomer, molded to size or cut from a molded sheet; Type A Shore durometer hardness of 50 to 70, ASTM D 2240; and minimum tensile strength of 2250 psi, ASTM D 412.
- B. Random, Fiber-Reinforced Elastomeric Pads: Preformed, randomly oriented synthetic fibers set in elastomer with a Type A Shore durometer hardness of 70 to 90, ASTM D 2240.
- C. Cotton-Duck-Fabric-Reinforced Elastomeric Pads: Preformed, horizontally layered cotton-duck fabric bonded in elastomer with a Type A Shore durometer hardness of 80 to 100, ASTM D 2240.
- D. High-Density Plastic Strips: Multimonomer, nonleaching plastic.

2.10 GROUT

- A. Cement Grout: Portland cement, ASTM C 150/C 150M, Type I, and clean, natural sand, ASTM C 404. Mix at ratio of 1 part cement to 2-1/2 parts sand, by volume, with minimum water required for placement and hydration.
- B. Nonmetallic, Nonshrink Grout: Premixed, nonmetallic, noncorrosive, nonstaining grout containing selected silica sands, portland cement, shrinkage-compensating agents, and plasticizing and water-reducing agents; complying with ASTM C 1107, of consistency suitable for application.

2.11 MISCELLANEOUS MATERIALS

- A. Chemical Surface Retarder: Water-soluble, liquid set retarder with color dye, for horizontal concrete surface application, capable of temporarily delaying final hardening of concrete to depth of reveal or etch required of specified finish.
- B. Form Retarder: Chemical liquid set retarder, for application on hardened horizontal concrete and capable of temporarily delaying final hardening of newly placed concrete to depth of reveal specified.
 - 1. Mold Release: Solution specially formulated by manufacturer for use under form retarder.
- C. Flashing Reglets: Open type having continuous groove not less than 1-1/8 inches deep by 3/16 inch wide at opening and sloped upward to 45 degrees. Temporarily fill or cover face openings of reglets to prevent intrusion of concrete or debris.
 - 1. Stainless Steel: ASTM A 240/A 240M, Type 304, soft annealed, not less than 0.0187 inch thick.
 - 2. Copper Strip: ASTM B 370, Temper H00 or O60, not less than 16 oz./sq. ft..
 - 3. Hot-Dip Galvanized-Steel Sheet: ASTM A 653/A 653M, G90 coating, not less than 0.0217 inch thick.

2.12 REPAIR MATERIALS

- A. Bonding Agent: ASTM C 1059, Type II, nonredispersible, acrylic emulsion or styrene butadiene.
- B. Patching Mortar: Dry-pack mix consisting of 1 part portland cement to 2-1/2 parts fine aggregate passing No. 16 sieve, using only enough water for handling and placing.

2.13 CONCRETE MIXTURES

- A. Obtain each color, size, type, and variety of concrete mixture from single manufacturer with resources to provide concrete of consistent quality in appearance and physical properties.
- B. Prepare design mixtures for each type and strength of concrete, proportioned on basis of laboratory trial mixture or field test data, or both, according to ACI 301.
 - 1. Use a qualified independent testing agency for preparing and reporting proposed concrete design mixtures based on laboratory trial mixtures.
- C. Proportion concrete mixture as follows:
 - 1. Minimum Compressive Strength: 4000 psi at 28 days.
 - 2. Maximum W/C Ratio: As determined by Concrete Mix Designer to meet project requirements .
 - 3. Slump Limit: As determined by Concrete Mix Designer to meet project requirements , plus or minus 1 inch.
 - 4. Air Content: percent plus or minus 1.5 percent for 1-1/2-inch nominal maximum aggregate size at point of delivery.
 - 5. Air Content: 6 percent plus or minus 1.5 percent for 1-inch nominal maximum aggregate size at point of delivery.
 - 6. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete according to ACI 301 requirements.
- D. Limit water-soluble, chloride-ion content in hardened concrete to 0.30 percent by weight of cement.
- E. Admixtures: Use admixtures according to manufacturer's written instructions.
 - 1. Use water-reducing high-range, water-reducing or plasticizing admixture in concrete, as required, for placement and workability.
 - 2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.

2.14 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M, and furnish batch ticket information.
 - 1. When air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.01 FORMWORK INSTALLATION

- B. Construct and brace formwork so tilt-up concrete panels are of size, shape, alignment, elevation, and position indicated.
 - 1. Construct forms on slab-on-grade or on temporary casting slab, at Contractor's option.
 - 2. Provide for openings, offsets, recesses, reveals, rustications, reglets, and blockouts.
 - 3. Place form liners accurately to provide finished surface texture indicated. Provide solid backing and supports to maintain stability of liners during concreting. Coat form liner with form-release agent.
- C. Construct forms for easy removal without hammering or prying against concrete surfaces. Use kerfed inserts, such as those forming reglets, rustications, and recesses, for easy removal.
- D. Set edge forms for panels to achieve required panel thickness.
- E. Chamfer exposed corners and edges, unless otherwise indicated, using chamfer strips fabricated to produce uniform, smooth lines and tight edge joints.
- F. Coat contact surfaces of wood forms and chamfers with sealer before placing reinforcement.

3.02 BOND BREAKER INSTALLATION

- G. Uniformly and continuously apply two coats of bond breaker to casting-slab surfaces by power spray or roller according to manufacturer's written instructions, before placing steel reinforcement. Recoat areas subjected to moisture before drying. Maintain continuity of coating until concrete placement.
- H. After placing steel reinforcement, touch up or recoat worn or damaged areas with bond breaker. Do not splash or coat steel reinforcement and inserts.

3.03 FORM RETARDER APPLICATION

- I. Uniformly and continuously apply form retarder to slab surfaces by power spray, roller, or brush according to manufacturer's written instructions, before placing steel reinforcement. Recoat areas subjected to moisture before drying. Maintain continuity of coating until concrete placement.
 - 1. Uniformly apply mold release according to manufacturer's written instructions and allow it to dry before applying form retarder.
- A. After placing steel reinforcement, touch up or recoat worn or damaged areas with form retarder. Do not splash or coat steel reinforcement and inserts.

3.04 REINFORCEMENT AND INSERT INSTALLATION

- A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating and placing reinforcement.
- B. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover.
 - 1. Field weld reinforcement according to AWS D1.4/D1.4M, where indicated.
 - 2. Do not tack-weld crossing reinforcing bars.
 - 3. Set wire ties so ends are directed into concrete, not toward exposed concrete surfaces.
- C. Accurately place and securely support embedded items, anchorages, inserts, cramps, retainers, bar chords and sleeves, and other items to be built into panels. Coordinate with other trades for installing cast-in items.

3.05 PANEL CASTING, GENERAL

- A. Comply with ACI 301 for handling, placing, and consolidating concrete.
- B. Maintain position of steel reinforcement, inserts, and anchors during concrete placement, consolidation, and finishing.
- C. Screed panel surfaces to correct level with a straightedge and strike off.
 - 1. Begin initial floating before excess moisture or bleedwater appears on the surface. Use bull floats or darbies to form a uniform and open-textured surface plane free of humps or hollows. Do not disturb panel surfaces before beginning finishing operations.
- D. Form chamfers at top edges of panel perimeters, openings, and similar locations not formed by chamfer strips unless otherwise indicated.
- E. Surface Defects: Limit visible surface defects to those permitted by TCA's "Tilt-up Concrete Association's Guideline Specifications" for Grade A, Architectural Grade B, Standard panel surfaces.

3.06 SANDWICH-PANEL CASTING

- A. Cast and screed supported wythe over casting slab.
- B. Wythe Connectors:
 - 1. While concrete is still plastic, place polyethylene sheet over top surface, overlapping sheet edges 6 inches and extending beyond edges of panels.
 - 2. Immediately place insulation, abutting edges and ends between boards. Stagger end joints between rows. Stagger joints of insulation layers one-half of board apart. Insert wythe connectors through predrilled insulation, and consolidate concrete

around connectors according to manufacturer's written instructions.

3. Cast, screed, and apply initial float finish to structural wythe.
4. CASTING TOLERANCES
5. Cast tilt-up concrete panels without exceeding the following tolerances:
6. Height and Width of Panels:
7. For Panels up to 20 Feet Tall: 1/4 inch wide.
8. For Panels 20 to 30 Feet Tall: 3/8 inch wide.
9. Each Additional 10 Feet in Excess of 30 Feet Tall: 1/8 inch wide.
10. Thickness: 3/16 inch.
11. Skew of Panel or Opening: Difference in length of diagonals of 1/8 inch per 72 inches with a maximum difference of 1/2 inch.
12. Openings Cast into Panel:
13. Size of Opening: 1/4 inch.
14. Location of Centerline of Opening: 1/4 inch.
15. Location and Placement of Embedded Items:
16. Inserts, Bolts, and Pipe Sleeves: 3/8 inch.
17. Lifting and Bracing Inserts: As required by manufacturer.
18. Lateral Placement of Weld Plate Embedments: 1 inch.
19. Tipping and Flushness of Weld Plate Embedments: 1/4 inch.
20. Deviation of Steel Reinforcement Cover: Maintain minimum cover required by ACI 301.
21. FACE-UP FINISHES
22. Float Finish: Consolidate surface of plastic concrete with power-driven floats or by hand floating. Restraighten and cut down high spots and fill low spots. Repeat float passes and restraighten until surface is left with a uniform, smooth, granular texture.
23. FACE-DOWN FINISHES
24. Smooth, As-Cast Finish: Cast panel to produce a surface free of pockets, sand streaks, and honeycombs. Produce a surface appearance of uniform color and texture.

25. Form-Liner Finish: Cast panel over form liners placed, secured, and sealed over casting slab to produce a textured surface free of pockets, streaks, and honeycombs. Produce a surface appearance of uniform color and texture.
 26. CONCRETE PROTECTING AND CURING
 27. Protect freshly placed concrete from premature drying and excessive cold or hot temperatures according to ACI 301.
 28. Apply evaporation retarder in hot, dry, or windy weather to protect concrete from rapid moisture loss before and during finishing operations. Apply according to manufacturer's written instructions after screeding and bull floating concrete, but before float finishing.
- C. Begin curing immediately after finishing concrete. Cure by one or a combination of the following methods according to ACI 308.1:
1. Moisture Curing: Keep surfaces continuously moist for no fewer than seven days with the following materials:
 - a. Water.
 - b. Continuous water-fog spray.
 - c. Absorptive cover, water saturated and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.
 2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Cure for no fewer than seven days. Immediately repair any holes or tears during curing period, using cover material and waterproof tape.
 3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

3.07 ERECTION

- A. Use erection equipment with care to prevent damage to floor slabs and panels.
- B. Lift, support, and erect panels only at designated lifting or supporting points indicated on Shop Drawings.
- C. Do not erect panels until 75 percent of 28-day compressive strength of concrete has been verified.
- D. Do not erect panels until verified compressive strength of concrete exceeds .
- E. Install tilt-up concrete panels level, plumb, square, and true. Place panels on leveled grout-

setting pads or shims in correct position. Maintain joint width of 3/4 inch between panels.

1. Install tilt-up concrete panels with face-down surfaces exposed to exterior of building.
- F. Temporarily brace and support panels securely in position against loads comparable in intensity to those for which structure was designed. Maintain braces and supports in place, undisturbed, until entire integrated supporting structure has been completed and permanent connections to panels are secured.
- G. Anchor panels in place and, if indicated, to one another.
1. Weld steel connectors to steel supports and embedments indicated, complying with AWS D1.1/D1.1M.
- H. Solidly grout-fill gaps between foundation system and bottom of panels.

3.08 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a special inspector and qualified testing and inspecting agency to perform tests and inspections and prepare test reports.
- B. Inspections:
1. Steel reinforcement placement.
 2. Steel reinforcement welding.
 3. Headed bolts and studs.
 4. Verification of use of required design mixture.
 5. Concrete placement, including conveying and depositing.
 6. Curing procedures and maintenance of curing temperature.
 7. Verification of concrete strength before erection of tilt-up panels.
- C. Testing Services: Tests shall be performed according to ACI 301.
- D. Tilt-up concrete panels will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports.

3.09 ERECTION TOLERANCES

- A. Install tilt-up concrete panels without exceeding the following erection tolerances:
1. Joint Width Variation (Exterior Face): Without decreasing or increasing more than 50 percent from specified joint width, maintain joint width as follows:

- a. For Panels up to 20 Feet Tall: 1/4 inch.
 - b. Each Additional 10 Feet in Excess of 20 Feet Tall: 1/8 inch.
2. Joint Taper: Maximum 3/8 inch over length, but not greater than the following:
- a. For Panels up to 20 Feet Tall: 1/4 inch.
 - b. Each Additional 10 Feet in Excess of 20 Feet Tall: 1/8 inch.
3. Panel Alignment:
- a. Alignment of Horizontal and Vertical Joints: 1/4 inch.
 - b. Offset in Exterior Face of Adjacent Panels: 1/4 inch.

3.10 FILLING AND REPAIR

- A. Patch holes and voids left by erecting and bracing inserts on tilt-up panels and slabs-on-grade. Cut or chip edges of voids perpendicular to concrete surface. Fill blockouts where indicated.
 1. Clean, dampen with water, and brush-coat holes, voids, and blockouts with bonding agent. Fill and compact with patching mortar of a stiff consistency before bonding agent has dried.
 2. Finish surfaces of fills and repairs to Architect's approval, with materials of same colors and textures as finishes on surrounding surfaces.
- B. Repair damaged galvanized-steel surfaces of connectors by cleaning and applying a coat of zinc repair paint.
- C. Repair damage to tilt-up panels and slabs-on-grade resulting from tilt-up work, as directed by Architect.
- D. Remove and replace tilt-up panels that do not comply with requirements in this Section.
- E. Demolish and remove temporary concrete casting slabs.

END OF SECTION 03 47 13

SECTION 04 29 00
ENGINEERED UNIT MASONRY

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.
- B. Section 01 11 00 "Summary of Work" for all Buy America Build America Act (BABA) requirements.

1.02 SUMMARY

- A. This Section consists of furnishing all the labor, materials, and services incidental to the installation of engineered unit masonry.

1.03 DEFINITIONS

- A. Engineered Unit Masonry: Masonry other than empirically designed walls and veneer, and all masonry indicated on Structural drawings within the Contract Documents.

1.04 SUBMITTALS

- A. General: Submit the following according to Conditions of the Contract and Division 1 Specification Sections. In addition to Division 1 requirements, provide one half-size hard copy (paper) of any drawings submitted in the electronic files.
- B. Shop Drawings: Submit shop drawings for fabrication, bending, and placement of reinforcement bars. Comply with ACI 315 "Manual of Standard Practice for Detailing Reinforced Concrete Structures". Show bar schedules, diagrams of bent bars, stirrup spacing, lateral ties and other arrangements and assemblies as required for fabrication and placement of reinforcement for unit masonry work. Submit shop drawings showing wall elevations with all masonry openings and reinforcement.
- C. Material certificates in lieu of material laboratory test reports when permitted by Architect/Engineer. Material certificates shall be signed by manufacturer and Contractor, certifying that each material item complies with or exceeds specified requirements. Provide certification from admixture manufacturers that chloride content complies with specification requirements.
- D. Testing Reports: The independent testing laboratory shall submit laboratory test reports for materials used directly to the Architect/Engineer with copy to others in accordance with the provisions of Division 1 Section "Quality Control Services." State in each report whether or not the test specimens comply to the specified requirements, and indicate any deviations therefrom.

1.05 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualified according to ASTM C 1093 for testing indicated.

- B. Quality Assurance Requirements: Comply with [Level B] [Level C] Quality Assurance requirements contained in TMS 602/ACI 530.1/ASCE 6.
- C. Special Inspections: Comply with special inspections required by building code indicated on Contract Documents.

1.06 DELIVERY, STORAGE AND HANDLING

1.07 FIELD CONDITIONS

- A. Do not apply floor loads, roof loads, and other construction loads to un-shored engineered masonry until the 28-day design strength has been obtained.
- B. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.
- C. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.

PART 2 - PRODUCTS

2.01 UNIT MASONRY

- A. General: Refer to Division 4 Section "Unit Masonry" for masonry materials and accessories not included in this Section.

2.02 CONCRETE MASONRY UNITS

- A. Concrete Masonry Units: Comply with ASTM C 90.
 - 1. Masonry Assembly Compressive Strength (f'm): minimum of 2,000 psi.
 - 2. Unit Compressive Strength: minimum of 2,000 psi, average of three units on the net area.
 - 3. Density Classification: [Normal weight] unless otherwise indicated.

2.03 MORTAR AND GROUT MATERIALS

- A. Mortar for Engineered Unit Masonry: Comply with ASTM C 270, Proportion Specification. Provide the following types of mortar for applications stated unless another type is indicated
 - 1. For engineered unit masonry, use Type S.
 - 2. Masonry cement is not permitted.
- B. Grout for Engineered Unit Masonry: Comply with ASTM C 476.
 - 1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse)

that will comply with TMS 602/ACI 530.1/ASCE 6 for dimensions of grout spaces and pour height.

2. Proportion grout in accordance with ASTM C 476, paragraph 4.2.2 for specified 28-day compressive strength indicated, but not less than 2500 psi (14 MPa).
 3. Provide grout with a slump of 8 to 11 inches as measured according to ASTM C 143/C 143M.
- C. Cold-Weather Admixture: Not permitted without written approval of the Engineer of record.

2.04 REINFORCEMENT

- A. Uncoated-Steel Reinforcing Bars: ASTM A 615/A 615M or ASTM A 996/A 996M, Grade 60.
- B. Masonry-Joint Reinforcement, General: ASTM A 951/A 951M.
1. Wire Diameter: W1.7 for side and cross rods.
- C. Masonry-Joint Reinforcement: Truss or ladder designs as follows

2.05 MISCELLANEOUS MASONRY ACCESSORIES

- A. Preformed Control-Joint Gaskets: Made from styrene-butadiene-rubber compound, complying with ASTM D 2000, Designation M2AA-805 and designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.

PART 3 - EXECUTION

3.01 PLACING REINFORCEMENT

- A. General: Comply with requirements in TMS 602/ACI 530.1/ASCE 6.
- B. Clean reinforcement loose rust, mill scale, earth, ice or other materials which will reduce bond to mortar or grout. Do not use reinforcement bars with kinks or bends not shown on drawings or final shop drawings, or bars with reduced cross-section due to excessive rusting or other causes.
- C. Position reinforcing accurately at the spacing indicated. Support secure vertical bars against displacement. Horizontal reinforcing may be placed as the masonry work progresses. Provide minimum clearance between reinforcing bars and between masonry and reinforcement as indicated on the Contract Documents, but not less than that specified by TMS 602/ACI 530.1/ASCE 6.
- D. Splice reinforcement bars where shown; do not splice at other points unless acceptable to the Architect. Provide lapped splices, unless otherwise indicated. In splicing vertical bars or attaching to dowels, lap ends, place in contact and wire tie.
- E. Embed metal ties in mortar joints as work progresses, with a minimum mortar cover of 5/8" on exterior face of walls and 1/2" at other locations.

- F. Embed prefabricated horizontal joint reinforcement as the work progresses, with a minimum cover of 5/8" on exterior face of walls and 1/2" at other locations. Lap units not less than 6" at ends. Use prefabricated "L" and "T" units to provide continuity at corners and intersections. Cut and bend units as recommended by manufacturer for continuity at returns, offsets, column fireproofing, pipe enclosures and other special conditions.
- G. Anchoring: Anchor reinforced masonry work to supporting structure as indicated.
 - 1. Anchor reinforced masonry walls to non-reinforced masonry where they intersect.
- H. Foundation dowels: Dowels in the foundation shall be placed to align with cores containing reinforcement.

3.02 INSTALLATION, GENERAL

- A. Refer to Section 042000 "Unit Masonry" for general installation requirements to unit masonry.
- B. Temporary Formwork: Provide formwork and shores as required for temporary support of reinforced masonry elements.
 - 1. Construct Formwork to conform to shape, line and dimensions shown. Make sufficiently tight to prevent leakage of mortar grout, or concrete (if any). Brace, tie and support as required to maintain portion and shape during construction and curing of reinforced masonry.
- C. Do not remove forms and shores until reinforced masonry member have hardened sufficiently to carry their own weight and all other reasonable temporary loads that may be placed on them during construction.
 - 1. Allow not less than the following minimum time to elapse after completion of members before removing shores or forms, provided suitable curing conditions have been obtained during the curing period.
 - a. 10 days for girders and beams.

3.03 INSTALLATION OF REINFORCED CONCRETE UNIT MASONRY

- A. Do not wet concrete masonry units (CMU).
- B. Lay CMU units with full-face shell mortar beds. Fill vertical head joints (end joints between units) solidly with mortar from face of unit to a distance behind face equal to not less than the thickness of longitudinal face shells. Solidly bed cross-webs of starting courses in mortar. Maintain head and bed joint widths shown, or if not shown, provide 3/8" joints.
 - 1. [Where solid CMU units are shown, lay with full mortar head and bed joints.]
- C. Walls:
 - 1. Pattern Bond: Lay CMU wall units in 1/2 running bond with vertical joints in each course centered on units in courses above and below, unless otherwise indicated.

Bond and interlock each course at corners and intersections. Use special-shaped units where shown, and as required for corners, jambs, sash, control joints, lintels, bond beams and other special conditions.

2. Maintain vertical continuity of core or cell cavities, which are to be reinforced and grouted, to provide minimum clear dimensions indicated and to provide minimum clearance and grout coverage for vertical reinforcement bars. Keep cavities free of mortar. Solidly bed webs in mortar where adjacent to reinforced cores or cells.
3. Where horizontal reinforced beams (bond beams) are shown, use special units or modify regular units to allow for placement of continuous horizontal reinforcement bars. Place small mesh expanded metal lath or wire screening in mortar joints under bond beam courses over cores or cells of non-reinforced vertical cells, or provide units with solid bottoms.
4. Columns, Piers and Pilasters:
 - a. Use CMU units of the size, shape and number of vertical core spaces shown. If not shown, use units which provide minimum clearances and grout coverage for number and size of vertical reinforcement bars shown.
 - b. Provide pattern bond shown, or if not shown, alternate head joints in vertical alignment.
 - c. Lay wall and pilaster units together to maximum pour height specified.

D. Grouting:

1. Use "Fine Grout" per ASTM C 476 for filling spaces less than 4" in one or both horizontal directions and bond beams.
2. Use "Coarse Grout" per ASTM C 476 for filling 4" spaces or larger in both horizontal directions and formed beams.
3. Grout lift heights and minimum clear dimensions shall comply with TMS 602/ACI 530.1/ASCE 6.

E. Low-Lift Grouting: Pour height of 5.33' or less

1. Use Low-Lift grouting technique for all walls and bond beams.
2. Place vertical reinforcement prior to laying of CMU. Extend above elevation of maximum pour height as required for splicing. Support in position at vertical intervals not exceeding 192 bar diameters nor 10 ft.
3. Place horizontal beam reinforcing as the masonry units are laid.
4. Lay CMU to maximum pour height. Do not exceed 5.33' height, or if bond beam occurs below 5.33' height stop pour at course below bond beam.
5. Pour grout using chute or container with spout. Rod or vibrate grout during placing. Place grout continuously; do not interrupt pouring of grout for more than

one hour. Terminate grout pours 1-1/2" below top course of pour.

6. Bond Beams: Stop grout in vertical cells 1-1/2" below bond beam course. Place horizontal reinforcing in bond beams; lap at corners and intersections as shown. Place grout in bond beam course before filling vertical cores above bond beam.

F. High-Lift Grouting: Pour height greater than 5.33' and meeting the requirements of TMS 602/ACI 530.1/ASCE 6

1. High-lift grouting technique may be used for the following masonry construction:
 - a. Columns, piers, pilasters, or formed beams.
2. Provide cleanout holes in first course of each grout pour at all vertical cells which are to be filled with grout.
 - a. Use units with one face shell removed and provide temporary supports for units above, or use header units with concrete brick supports, or cut openings in one face shell.
3. Construct masonry to full height of maximum grout specified, prior to placing grout.
 - a. Limit grout lifts to a maximum height of 5.33' and grout pour to a maximum height of 12.67', unless otherwise indicated.
4. Place vertical reinforcement before grout placement. Place before or after laying masonry units, as required by job conditions. Tie vertical reinforcement to dowels at base of masonry where shown and thread CMU over or around reinforcement. Support vertical reinforcement at intervals not exceeding 192 bar diameters nor 10'.
 - a. Where individual bars are placed after laying masonry, place wire loops extending into cells as masonry is laid and loosen before mortar sets. After insertion of reinforcing bar, pull loops and bar to proper position and tie free ends.
5. Where reinforcement is prefabricated into cage units before placing, fabricate units with vertical reinforcement bars and lateral ties of the size and spacing indicated.
6. Embed lateral tie reinforcement in mortar joints where indicated. Place as masonry units are laid, at vertical spacing shown.
 - a. Where lateral ties are shown in contact with vertical reinforcement bars, embed additional lateral tie reinforcement in mortar joints. Place as shown, or if not shown, provide as required to prevent grout blowout or rupture of CMU face shells, but provide not less than No. 2 bars or 8 gage wire ties spaced 16" o.c. for members with 20" or less side dimensions, and 8" o.c. for members with side dimensions exceeding 20".
7. Preparation of Grout Spaces: Prior to placement, inspect and clean grout spaces.

Remove dust, dirt, mortar droppings, loose pieces of masonry and other foreign materials from grout spaces. Clean reinforcing and adjust to proper position. Clean top surface of structural members supporting masonry to ensure bond. After final cleaning and inspection, close cleanout holes and brace closures to resist grout pressures.

- a. Do not place grout until entire height of masonry to be poured has attained sufficient strength to resist displacement of masonry units and breaking of mortar bond. Install shores and bracing, if required, before starting grouting operations.
- b. Place grout by pumping into grout spaces unless alternate methods are acceptable to the Architect.
- c. Limit grout pours to sections which can be completed in one working day with not more than one hour interruption of pouring operation. Place grout in lifts which do not exceed 5.33'. Allow not less than 30 minutes, nor more than one hour between lifts of a given pour. Rod or vibrate each grout lift during pouring operation.
- d. When more than one pour is required to complete a given section of masonry, extend reinforcement beyond masonry as required for splicing. Pour grout to within 1-1/2" of top course of first pour. After grouted masonry is cured, lay masonry units and place reinforcement for second pour section. Repeat sequence if more pours are required.

3.04 FIELD QUALITY CONTROL

- A. Comply with quality control requirements of Section 042000 "Unit Masonry".
- B. Special Inspections: Owner will engage a special inspector and qualified testing and inspecting agency to perform tests and inspections and prepare test reports.
- C. Inspections: Comply with [Level B] [Level C] Quality Assurance requirements contained in TMS 602/ACI 530.1/ASCE 6.
 1. Begin masonry construction only after inspectors have verified proportions of site-prepared mortar.
 2. Place grout only after inspectors have verified compliance of grout spaces and of grades, sizes, and locations of reinforcement.
 3. Place grout only after inspectors have verified proportions of site-prepared grout.
- D. Minimum Tests and Submittals:
 1. Certificate for materials used in masonry construction indicating compliance with contract documents.
 2. Verification of Minimum masonry compressive strength (f'_m) prior to construction and every 5000 sq. ft during construction. Perform compressive

strength "Prism Test" per ASTM C1314.

3. Verification of proportions of materials and grout as delivered to the site.
 4. Test mortar in accordance with the property specification of ASTM C 270 or evaluate with ASTM C 780.
 5. Sample and test grout in accordance with ASTM C 1019 for each 5000 sq. ft.
- E. Test results will be reported in writing to Architect, Structural Engineer, and Contractor within 24 hours after tests. Reports of tests shall contain the Project identification name and number, date of test, name of testing service, mortar or grout type and class, location of mortar or grout batch in structure, design compressive strength at 28 days, mortar or grout mix proportions and materials, compressive breaking strength, and type of break for both 7-day tests and 28-day tests. If any breaks are below specified or expected strengths, the Testing Laboratory shall report any visible anomalies.
- F. Additional Tests: The testing agency will make additional tests of in-place masonry when test results indicate specified strengths and other characteristics have not been attained in the structure, as directed by Architect/Engineer.
1. For each 5,000 sq ft of wall that does not meet the required compressive strength, prisms shall be sampled, removed and tested in accordance with the requirements of TMS 602/ACI 530.1/ASCE 6.

END OF SECTION 04 29 00

SECTION 05 12 00
STRUCTURAL STEEL FRAMING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:

1. Structural steel.
2. Grout.

B. Related Requirements:

1. Section 011100 "Summary of Work" for all Buy America Build America Act (BABA) requirements.
2. Section 051213 "Architecturally Exposed Structural Steel Framing" for additional requirements for architecturally exposed structural steel.
3. Section 053100 "Steel Decking" for field installation of shear connectors through deck.
4. Section 055000 "Metal Fabrications" for miscellaneous steel fabrications not defined as structural steel.
5. Section 099113 "Exterior Painting" and Section 099123 "Interior Painting" for surface-preparation and priming requirements.
6. Section 133419 "Metal Building Systems" for structural steel.

1.03 DEFINITIONS

- A. Structural Steel: Elements of the structural frame indicated on Drawings and as described in AISC 303, "Code of Standard Practice for Steel Buildings and Bridges."
- B. Seismic-Load-Resisting System: Elements of structural-steel frame designated as "SLRS" or along grid lines designated as "SLRS" on Drawings, including columns, beams, and braces and their connections.
- C. Heavy Sections: Rolled and built-up sections as follows:
1. Shapes included in ASTM A 6/A 6M with flanges thicker than 1-1/2 inches.
 2. Welded built-up members with plates thicker than 2 inches.

3. Column base plates thicker than 2 inches.
- D. Protected Zone: Structural members or portions of structural members indicated as "Protected Zone" on Drawings. Connections of structural and nonstructural elements to protected zones are limited.
- E. Demand Critical Welds: Those welds, the failure of which would result in significant degradation of the strength and stiffness of the Seismic-Load-Resisting System and which are indicated as "Demand Critical" or "Seismic Critical" on Drawings.

1.04 COORDINATION

- A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.
- B. Coordinate installation of anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, sheet metal templates, instructions, and directions for installation.

1.05 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at via zoom. .

1.06 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Show fabrication of structural-steel components.
 1. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
 2. Include embedment Drawings.
 3. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld. Show backing bars that are to be removed and supplemental fillet welds where backing bars are to remain.
 4. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pretensioned and slip-critical, high-strength bolted connections.
 5. Identify members and connections of the Seismic-Load-Resisting System.
 6. Indicate locations and dimensions of protected zones.
 7. Identify demand critical welds.
- C. Delegated-Design Submittal: For structural-steel connections indicated to comply with design loads, include analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.07 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: For the following:
 - 1. Bolts, nuts, and washers including mechanical properties and chemical analysis.
 - 2. Direct-tension indicators.
 - 3. Tension-control, high-strength, bolt-nut-washer assemblies.
 - 4. Shear stud connectors.
 - 5. Shop primers.
 - 6. Nonshrink grout.
- B. Field quality-control and special inspection reports.

1.08 QUALITY ASSURANCE

- A. Fabricator Qualifications: A qualified fabricator that participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category STD.
- B. Installer Qualifications: A qualified installer who participates in the AISC Quality Certification Program and is designated an AISC-Certified Erector, .
- C. Shop-Painting Applicators: Qualified according to AISC's Sophisticated Paint or to SSPC-QP 3, "Standard Procedure for Evaluating Qualifications of Shop Painting Applicators."
- D. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
 - 1. Welders and welding operators performing work on bottom-flange, demand-critical welds shall pass the supplemental welder qualification testing, as required by AWS D1.8/D1.8M. FCAW-S and FCAW-G shall be considered separate processes for welding personnel qualification.
- E. Comply with applicable provisions of the following specifications and documents:
 - 1. AISC 303.
 - 2. AISC 341 and AISC 341s1.
 - 3. AISC 360.
 - 4. RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

1.09 DELIVERY, STORAGE, AND HANDLING

- A. Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from corrosion and deterioration.

1. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.
- B. Store fasteners in a protected place in sealed containers with manufacturer's labels intact.
1. Fasteners may be repackaged provided Owner's testing and inspecting agency observes repackaging and seals containers.
 2. Clean and relubricate bolts and nuts that become dry or rusty before use.
 3. Comply with manufacturers' written recommendations for cleaning and lubricating ASTM F 1852 fasteners and for retesting fasteners after lubrication.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Connections: Provide details of simple shear connections required by the Contract Documents to be selected or completed by structural-steel fabricator, including comprehensive engineering analysis by a qualified professional engineer, to withstand loads indicated and comply with other information and restrictions indicated.
1. Select and complete connections using schematic details indicated and AISC 360.
 2. Use Allowable Stress Design; data are given at service-load level.
- B. Moment Connections: Type FR, fully restrained.
- C. Construction: Shear wall system

2.02 STRUCTURAL-STEEL MATERIALS

- A. Wide Flanges: A992
- B. Channels, Angles -Shapes: ASTM A 36/A 36M .
- C. Plate and Bar: ASTM A 36/A 36M .
- D. Cold-Formed Hollow Structural Sections: ASTM A 500/A 500M, Grade C, structural tubing.

2.03 BOLTS, CONNECTORS, AND ANCHORS

- A. High-Strength Bolts, Nuts, and Washers: ASTM A 490, Type 1, heavy-hex steel structural bolts or tension-control, bolt-nut-washer assemblies with splined ends; ASTM A 563, Grade DH, heavy-hex carbon-steel nuts; and ASTM F 436, Type 1, hardened carbon-steel washers with plain finish.
1. Direct-Tension Indicators: ASTM F 959, Type 490, compressible-washer type with plain finish.

- B. Threaded Rods: ASTM A 572/A 572M, Grade 50.
 - 1. Nuts: ASTM A 563 heavy-hex carbon steel.
 - 2. Washers: ASTM A 36/A 36M carbon steel.
 - 3. Finish: Hot-dip zinc coating, ASTM A 153/A 153M, Class C .
- C. Made from cold-finished carbon steel bars, ASTM A 108, Grade 1035.
- D. Structural Slide Bearings: Low-friction assemblies, of configuration indicated, that provide vertical transfer of loads and allow horizontal movement perpendicular to plane of expansion joint while resisting movement within plane of expansion joint.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Amscot Structural Products Corp.
 - b. Fluorocarbon Company Limited.
 - c. GRM Custom Products.
 - d. R.J. Watson Bridge & Structural Engineered Systems.
 - 2. Mating Surfaces: PTFE and PTFE .
 - 3. Coefficient of Friction: Not more than 0.06 .
 - 4. Design Load: Not less than 5,000 psi .
 - 5. Total Movement Capability: 2 inches .

2.04 PRIMER

- A. Primer: Comply with
- B. Primer: SSPC-Paint 25, , zinc oxide, alkyd, linseed oil primer.
- C. Primer: SSPC-Paint 25 BCS, , zinc oxide, alkyd, linseed oil primer.
- D. Primer: Fabricator's standard lead- and chromate-free, nonasphaltic, rust-inhibiting primer complying with MPI#79 and compatible with topcoat.
- E. Galvanizing Repair Paint: MPI#18, MPI#19, or SSPC-Paint 20 ASTM A 780/A 780M.

2.05 GROUT

- A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107/C 1107M, factory-packaged, nonmetallic aggregate grout, noncorrosive and nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

2.06 FABRICATION

- A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate according to AISC 303, "Code of Standard Practice for Steel Buildings and Bridges," and to AISC 360.
 - 1. Camber structural-steel members where indicated.
 - 2. Fabricate beams with rolling camber up.
 - 3. Identify high-strength structural steel according to ASTM A 6/A 6M and maintain markings until structural steel has been erected.
 - 4. Mark and match-mark materials for field assembly.
 - 5. Complete structural-steel assemblies, including welding of units, before starting shop-priming operations.
- B. Bolt Holes: Cut, drill, or punch standard bolt holes perpendicular to metal surfaces.
- C. Finishing: Accurately finish ends of columns and other members transmitting bearing loads.
- D. Cleaning: Clean and prepare steel surfaces that are to remain unpainted according to SSPC-SP 1, "Solvent Cleaning." SSPC-SP 2, "Hand Tool Cleaning." SSPC-SP 3, "Power Tool Cleaning."
- E. Holes: Provide holes required for securing other work to structural steel and for other work to pass through steel members.
 - 1. Cut, drill, or punch holes perpendicular to steel surfaces. Do not thermally cut bolt holes or enlarge holes by burning.
 - 2. Baseplate Holes: Cut, drill, mechanically thermal cut, or punch holes perpendicular to steel surfaces.
 - 3. Weld threaded nuts to framing and other specialty items indicated to receive other work.

2.07 SHOP CONNECTIONS

- A. High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.
 - 1. Joint Type: Snug tightened .
- B. Weld Connections: Comply with AWS D1.1/D1.1M and AWS D1.8/D1.8M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.
 - 1. Assemble and weld built-up sections by methods that maintain true alignment of

axes without exceeding tolerances in AISC 303 for mill material.

2.08 SHOP PRIMING

- A. Shop prime steel surfaces except the following:
1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches.
 2. Surfaces to be field welded.
 3. Surfaces of high-strength bolted, slip-critical connections.
 4. Surfaces to receive sprayed fire-resistive materials (applied fireproofing).
 5. Galvanized surfaces.
 6. Surfaces enclosed in interior construction.
- B. Surface Preparation: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces according to the following specifications and standards:
1. SSPC-SP 2, "Hand Tool Cleaning."
 2. SSPC-SP 3, "Power Tool Cleaning."
- C. Priming: Immediately after surface preparation, apply primer according to manufacturer's written instructions and at rate recommended by SSPC to provide a minimum dry film thickness of 1.5 mils. Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.
1. Stripe paint corners, crevices, bolts, welds, and sharp edges.
 2. Apply two coats of shop paint to surfaces that are inaccessible after assembly or erection. Change color of second coat to distinguish it from first.

2.09 GALVANIZING

- A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel according to ASTM A 123/A 123M.
1. Fill vent and drain holes that are exposed in the finished Work unless they function as weep holes, by plugging with zinc solder and filing off smooth.
 2. Galvanize lintels shelf angles and welded door frames attached to structural-steel frame and located in exterior walls.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify, with certified steel erector present, elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments for compliance with requirements.
 - 1. Prepare a certified survey of existing conditions. Include bearing surfaces, anchor rods, bearing plates, and other embedments showing dimensions, locations, angles, and elevations.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Provide temporary shores, guys, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place unless otherwise indicated.
 - 1. Do not remove temporary shoring supporting composite deck construction until cast-in-place concrete has attained its design compressive strength.

3.03 ERECTION

- A. Set structural steel accurately in locations and to elevations indicated and according to AISC 303 and AISC 360.
- B. Baseplates Bearing Plates and Leveling Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting plates. Clean bottom surface of plates.
 - 1. Set plates for structural members on wedges, shims, or setting nuts as required.
 - 2. Weld plate washers to top of baseplate.
 - 3. Snug-tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.
 - 4. Promptly pack grout solidly between bearing surfaces and plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.
- C. Maintain erection tolerances of structural steel within AISC 303, "Code of Standard Practice for Steel Buildings and Bridges."
- D. Align and adjust various members that form part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that are in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.
 - 1. Level and plumb individual members of structure.

2. Make allowances for difference between temperature at time of erection and mean temperature when structure is completed and in service.
- E. Splice members only where indicated.
 - F. Do not use thermal cutting during erection unless approved by Architect. Finish thermally cut sections within smoothness limits in AWS D1.1/D1.1M.
 - G. Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts.

3.04 FIELD CONNECTIONS

- A. High-Strength Bolts: Install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.
 1. Joint Type: Snug tightened .

3.05 REPAIRS AND PROTECTION

- A. Galvanized Surfaces: Clean areas where galvanizing is damaged or missing and repair galvanizing to comply with ASTM A 780/A 780M.

END OF SECTION 05 12 00

SECTION 05 12 13
ARCHITECTURALLY EXPOSED STRUCTURAL STEEL

PART 1 - GENERAL

1.01 RELATED WORK

- A. This Section includes requirements regarding the appearance and surface preparation of Architecturally Exposed Structural Steel. (AESS). Refer to division 5 section 'Structural Steel' for all other requirements regarding steel work not included in this section.
- B. SUMMARY OF WORK: Section 01 11 00:
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) Requirements

1.02 SUMMARY

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to the Section.
- B. Related Sections: The following Sections contain requirements that relate to this Section:
 - 1. SECTION 01 33 24: SUBMITTAL MATRIX
 - 2. SECTION 05 31 00: STEEL DECKING
 - 3. SECTION 05 12 00: STRUCTURAL STEEL FRAMING
 - 4. SECTION 09 91 00: PAINTING for finish coat requirements and coordination with primer and surface preparation specified in this section.

1.03 DEFINITIONS

- A. Architecturally Exposed Structural Steel: Structural Steel conforming to one of the categories of Architecturally Exposed Structural Steel or AESS Refer to ANSI/AISC 303-16 “Code of Standard Practice for Steel Buildings and Bridges”.
- B. AESS 1: Structural Steel designated as “AESS 1 in the contract documents and conforming to ANSI/AISC 303-16, Chapter 10 definition of AESS1. These are basic elements with workmanship requirements exceeding those in non AESS construction.
- C. AESS 2: Structural Steel designated as “AESS 2 in the contract documents and conforming to ANSI/AISC 303-16, Chapter 10 definition of AESS2. These are feature elements viewed at a distance greater than 20 feet. The art of metalworking is intended to be visible to the viewer.
- D. AESS 3: Structural Steel designated as “AESS 3 in the contract documents and conforming to ANSI/AISC 303-16, Chapter 10 definition of AESS3. These are feature elements viewed at a distance less than 20 feet. The art of metalworking is intended to be visible to the viewer.

- E. AESS 4: Structural Steel designated as “AESS 4 in the contract documents and conforming to ANSI/AISC 303-16, Chapter 10 definition of AESS4. These are showcase elements with special surface and edge treatment beyond fabrication. The intent is the form is the only feature showing in an element.
- F. AESS C: Structural Steel designated as “AESS C in the contract documents and conforming to ANSI/AISC 303-16, Chapter 10 definition of AESS C. These are custom AESS elements with characteristics described in the contract documents.

1.04 ACTION SUBMITTALS

- A. General: Submit each item below according to the Conditions of the Contract and Division 1 Specification Sections.
- B. Product Data for each type of product specified. Submit “Special Coatings” under Division 9.
- C. Fabrication Documents: Detailing for fabrication of AESS components.
 - 1. Provide erection documents clearly indicating which members are AESS members and the AESS category of each part.
 - 2. Include details that clearly identify all the requirements listed in sections 2.3 "Fabrication" and 3.3 "Erection" of this specification for each part. Provide connections for exposed AESS consistent with concepts shown on the architectural or structural drawings.
 - 3. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length and type of each weld. Identify grinding, finish, and profile of welds as defined herein.
 - 4. Indicate orientation of HSS seams and mill marks (where applicable).
 - 5. Indicate type, size, finish and length of bolts, distinguishing between shop and field bolts. Identify high-strength bolted slip-critical, direct-tensioned shear/bearing connections. [Indicate which direction bolt heads should be oriented.]
 - 6. Clearly indicate which surfaces or edges are exposed and what class of surface preparation is being used.
 - 7. Indicate special tolerances and erection requirements as noted on the drawings or defined herein.
 - 8. Indicate vent or drainage holes for HSS members.
- D. Mock Up: Provide mock ups of the nature and extent indicated on the contract documents.
 - 1. Locate mockups on-site or in the fabricator’s shop as directed by Architect. Mockups shall be full size unless the Architect approves smaller models. Alternatively, when a mockup is not practical, the first piece of an element or connection can be used to determine acceptability.

2. Notify the Architect one week in advance of the dates and times when mockups will be available for review.
 3. Demonstrate all applicable AESS characteristics for the specified category of AESS on the elements and joints in the mock up.
 4. Build mockups using member sizes and materials indicated for final Work.
 5. The mock up shall demonstrate weld quality and contouring of the welds at the aligned walls of the members.
 6. The mock up shall demonstrate the specified surface preparation and finish coating.
 7. HSS members shall extend at least 6" from the joint in the mock-up.
 8. Obtain Architect's written approval of mockups before starting fabrication
 9. Retain and maintain mockups during construction in an undisturbed condition as a standard for judging the completed work.
 - a. Approved mockups in an undisturbed condition at the time of Substantial Completion may become part of the completed work.
- E. Samples: Provide samples of specific AESS characteristics. Samples may be small size samples or components of conventional structural steel demonstrating the following specific AESS characteristics.
1. Continuous weld appearance
 2. Sharp edges ground smooth
 3. Surface preparation
 4. Fabrication mark removal
 5. Weld show through.

1.05 INFORMATIONAL SUBMITTALS

- A. General: Submit each item below according to the Conditions of the Contract and Division 1 Specification Sections.
- B. Qualification data for firms and persons specified in the 'Quality Assurance' Submittal to demonstrate their capabilities and experience. Include lists of completed projects names and address, names and addresses of architects and owners, and other information specified. For each project, submit photographs showing detail of installed AESS.

1.06 QUALITY ASSURANCE

- A. Fabricator Qualifications: In addition to those qualifications listed in Division 5 Section 'Structural Steel', engage an AISC Certified Fabricator, experienced in fabricating AESS

similar to that indicated for this Project with a record of successful in-service performance, as well as sufficient production capacity to fabricate AESS without delaying the Work.

- B. Erector Qualifications: In addition to those qualifications listed in Division 5 Section 'Structural Steel', engage an AISC Certified Erector, experienced in erecting AESS work similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.
- C. Comply with applicable provisions of the following specifications and documents:
 - 1. ANSI/AISC 303-16," Code of Standard Practice for Steel Buildings and Bridges", Section 10.
- D. Pre-installation Conference: Schedule and conduct conference at the project site to comply with requirements of Division 1 Section "Project Meetings." As a minimum, the meeting shall include the General Contractor, Fabricator, Erector, the finish-painting subcontractor, and the Architect. Coordinate requirements for shipping, special handling, storage, attachment of safety cables and temporary erection bracing, final coating, touch up painting, mock up coordination, architect's observations, and other requirements for AESS.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Deliver AESS to Project site in such quantities and at such times to ensure continuity of installation. All tie downs on loads shall be nylon straps or shall use softeners when using chains or wire rope slings to avoid damage to edges and surfaces of members. The standard for acceptance of delivered and erected members shall be equivalent to the standard employed at fabrication.
- B. Store materials to permit easy access for inspection and identification. Keep steel members off ground by using pallets, platforms, or other supports. Protect steel members and packaged materials from erosion and deterioration. Use special care in handling to prevent twisting or warping of AESS members.
- C. Handle finish pieces using nylon type slings, or chains with softeners, or wire ropes with softeners such that they are not damaged. Conform to ANSI/AISC 303-16 Sections 10.4, 10.5, and 10.6.

1.08 PROJECT CONDITIONS

- A. Field Measurements: Where AESS is indicated to fit against walls and other construction, verify dimensions by field measurements before fabrication and indicate measurements on Fabrication Documents. Coordinate fabrication schedule with construction progress to avoid delaying the work.

1.09 COORDINATION

- A. Coordinate installation of anchors for AESS members that connect to the work of other trades. Furnish setting drawings, templates, and directions for installing anchors, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to the project site in time for installation. Anchorage concepts shall be as indicated on drawings and approved on final

Fabrication Documents.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. All steel members exposed to weather (such as beams, columns, plates, bolts, lintels, door jambs, etc.) And all members in an exterior enclosed non-air-condition area, shall be galvanized
- B. General: Meet requirements Division 5 Section 'Structural Steel 05 12 23' as amended below.
- C. High-Strength Bolts, Nuts, and Washers: Per section 05 12 23 heavy hex heads and nuts Provide Mechanically galvanized finish.

2.02 FINISH SYSTEM

- A. Compatibility: All components/procedures of the AESS paint system shall conform to the coating system specified, submitted, and approved per Division 9. As a minimum identify required surface preparation, primer, intermediate coat (if applicable), and finish coat. Primer, intermediate coating and finish coating shall be from a single manufacturer combined in a system documented by the manufacturer with adequate guidance for the fabricator to procure and execute.
- B. Coating: All exposed elements and associated components shall be galvanized with G-90 minimum coating.
- C. Primer: Acrylic water-soluble shop coat with good resistance to normal atmospheric corrosion. Primer shall comply with all federal standards for VOC, lead and chromate levels.
- D. Primer: Fast curing two-part epoxy. Primer shall comply with all federal standards for VOC, lead and chromate levels.
- E. Primer: Organic, epoxy/zinc rich meeting class B surface requirements for slip critical connections. Primer shall comply with all federal standards for VOC, lead and chromate levels.
- F. Primer: Inorganic zinc rich meeting class B surface requirements for slip critical connections. Primer shall comply with all federal standards for VOC, lead and chromate levels.
- G. Zinc Rich Primer: High-zinc-dust-content paint for galvanized steel, with dry film coating not less than 90 percent zinc dust by weight.
- H. Finish Coating: Field apply intermediate and top coats per section 09 91 00.

2.03 FABRICATION AESS 1

- A. Use special care in handling and shipping of AESS both before and after shop painting minimize damage to any shop finish. Use Nylon type slings or softeners when using chains

or wire rope slings.

- B. The permissible tolerances for member depth, width, out of square, and camber and sweep shall be as specified in ASTM A6/A6M-2014 Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling (ASTM A6/A6M), ASTM A500/A500M-2013 Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes (ASTM A500/A500M), and Standard Specification for Cold-Formed Welded Carbon Steel Structural Sections (HSS) (ASTM A1085/A1085M).
- C. Fabricate and assemble AESS in the shop to the greatest extent possible. Locate field joints in AESS assemblies at concealed locations or as approved by the Architect. Detail AESS assemblies to minimize field handling and expedite erection.
- D. Remove blemishes or unsightly surfaces resulting from temporary braces or fixtures.
- E. Remove all backing and run out tabs.
- F. Grind all sharp edges smooth, including all sheared, punched or flame cut edges
- G. Provide a continuous appearance to all welded joints including tack welds. Provide joint filler at intermittent welds.
- H. Bolted Connections: Make in accordance with Section 05 10 00. Provide bolt type and finish as noted herein.
- I. Weld Connections: Comply with AWS D1.1 and Section 05 10 00. Appearance and quality of welds shall be consistent. Assemble and weld built-up sections by methods that will maintain alignment of members without warp exceeding the tolerance of this section.
- J. Install all bolts on the same side of the connection. Oriented uniformly in the direction indicated Consistent from one connection to another.
- K. Remove all weld spatter, slivers and similar surface discontinuities.
- L. Grind off projections larger than 1/16" at butt and plug welds.
- M. Continuous Weld Appearance: Where continuous welding is noted on the drawings, provide welds of a uniform size and profile
- N. Seal Welds: Seal weld open ends of round and rectangular hollow structural section with 3/8" closure plates. Provide venting as required for galvanized members.

2.04 FABRICATION AESS 2

- A. Fabricate to Requirements of 2.3 and as follows
- B. The as-fabricated straightness tolerance shall be one-half of that specified in ASTM A6/A6M, ASTM A500/A500M, or ASTM A1085/A1085M.
- C. For curved structural members, whether composed of a single standard structural shape or built-up, the as-fabricated variation from the theoretical curvature shall be

equal to or less than the standard camber and sweep tolerances permitted for straight members in the applicable ASTM standard.

- D. The tolerance on overall profile dimensions of welded built-up members shall one-half of that specified in AWS D1.1/D1.1M: 2015 Structural Welding Code – Steel (AWS D1.1).
- E. Provide hidden part marks or piece marks that may be fully removed after erection.

2.05 FABRICATION AESS 3

- A. Fabricate to Requirements of 2.4 and as follows
- B. Fabricate AESS with exposed surfaces smooth, square and of surface quality consistent with the approved mock up.
- C. Grind projections at butt and plug welds to be smooth with the adjacent surface.
- D. Orientation of HSS seams shall be as shown.

Copes, miters, and cuts in surfaces exposed to view shall have a maximum gap of 1/8” in an open joint. If the gap is shown to be in contact, the contact shall be uniform within 1/16”.

- E. Mill marks shall not be exposed to view. If it is not possible to hide mill marks, then the mill marks are to be removed by appropriate length cutting of mill material. If this is not possible, the fabricator shall remove the mill mark, grind, and fill the surface to be consistent with the approved mock up.
- F. The matching of abutting cross sections is required

2.06 FABRICATION AESS 4

- A. Fabricate to the requirements of 2.5 and as follows.
- B. Contouring and blending of welds: Where welds are indicated to be ground contoured, or blended, oversize welds as required and grind to provide a smooth transition and match profile on approved mock-up.
- C. Minimize Weld Show Through: At locations where welding on the opposite side of an exposed connection creates distortion, weld show through shall be minimized to conform to the approved mock up.
- D. Open holes shall be filled with weld metal or body filler and smoothed by grinding or filling to the standards applicable to the shop fabrication of the materials.

2.07 SHOP PRIMING

- A. Provide surface preparations to SSPC-SP6. Coordinate the required surface profile with the approved paint submittal prior to beginning surface preparation. Prior to blasting remove any grease and oil using solvent cleaning to meet SSPC-SP 1. Weld spatter, slivers and similar surface discontinuities shall be removed. Sharp corners resulting from shearing, flame cutting or grinding shall be eased.

- B. Shop prime steel surfaces, except the following:
 - 1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches.
 - 2. Surfaces to be field welded.
 - 3. Surfaces to be high-strength bolted with slip-critical connections,
- C. Priming: Immediately after surface preparation, apply primer according to manufacturer's instructions to provide a dry film thickness of not less than 1.5 mils (0.038 mm). Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.
 - 1. Stripe paint corners, crevices, bolts, welds, and sharp edges.
 - 2. Apply two coats of shop primer to surfaces that are inaccessible after assembly or erection.

2.08 GALVANIZING

- A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to AESS indicated for galvanizing according to ASTM A123/A123M – 2015 Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products. Fabricate such that all connections of assemblies are made in the field with bolted connections where possible.

2.09 FABRICATION QUALITY CONTROL AND QUALITY ASSURANCE AESS 1 AND 2

- A. Structural requirements:
 - 1. Conform to Quality Control requirements per ANSI/AISC 360-16 "Specification for Structural Steel Buildings" Chapter N and ANSI/AISC 303-16," Code of Standard Practice for Steel Buildings and Bridges", Section 10. Refer to Section 05 12 00 "Structural Steel" for additional requirements.
 - 2. Owner will engage a Quality Assurance agency per the requirements of ANSI/AISC 360-16 "Specification for Structural Steel Buildings" Chapter N and ANSI/AISC 303-16," Code of Standard Practice for Steel Buildings and Bridges", Section 10
- B. AESS acceptance: The Architect shall observe the AESS steel in the shop at a viewing distance consistent with the final installation and determine acceptability based on the qualification data and submittals. The Quality Assurance agency shall have no responsibility for enforcing the requirements of this section.

2.10 FABRICATION QUALITY CONTROL AND QUALITY ASSURANCE AESS 3 AND 4

- A. Conform to 2.10 and as follows.
- B. AESS acceptance: The Architect shall observe the AESS steel in the shop at a viewing distance consistent with the final installation and determine acceptability based on the approved mock up. The Quality Assurance Agency shall have no responsibility for enforcing the requirements of this section.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. The erector shall check all AESS members upon delivery for twist, kinks, gouges or other imperfections which may result in rejection of the appearance of the member. Coordinate remedial action with fabricator prior to erecting steel.

3.02 PREPARATION

- A. Provide connections for temporary shoring, bracing and supports only where noted on the approved Fabrication Documents. Temporary connections not shown shall be made at locations not exposed to view in the final structure or as approved by the Architect. Handle, lift and align pieces using nylon straps or chains with softeners required to maintain the appearance of the AESS through the process of erection.

3.03 ERECTION AESS 1

- A. Employ special care to handle and erect AESS. Erect finish pieces using nylon straps or chains with softeners such that they are not damaged.
- B. Place weld tabs for temporary bracing and safety cabling at points concealed from view in the completed structure or where approved by the Architect during the pre-installation meeting. Methods of removing temporary erection devices and finishing the AESS members shall be approved by the Architect prior to erection.
- C. AESS Erection tolerances: Erection tolerances shall meet the requirements of standard frame tolerances for structural steel per Chapter 7 of ANSI/AISC 303-16.
- D. Set AESS accurately in locations and to elevations indicated and according to AISC specifications referenced in this Section.
- E. Remove blemishes or unsightly surfaces resulting from temporary braces or fixtures.
- F. Remove all backing and run out tabs.
- G. When temporary braces or fixtures are required to facilitate erection, care shall be taken to avoid any blemishes, holes or unsightly surfaces resulting from the use or removal of such temporary elements.
- H. Bolted Connections: Align bolt heads on the same side of the connection as indicated on the approved fabrication or erection documents.
- I. Weld Connections: Comply with AWS D1.1 and Section 05 12 00. Appearance and quality of welds shall be consistent. Employ methods that will maintain alignment of members without warp exceeding the tolerance of this section.
- J. Remove all weld spatter exposed to view.
- K. Grind off projections larger than 1/16" at field butt and plug welds.
- L. Continuous Welds: Where continuous welding is noted on the drawings, provide

continuous welds of a uniform size and profile.

- M. Do not enlarge holes in members by burning or by using drift pins. Ream holes that must be enlarged to admit bolts. Replace connection plates that are misaligned where holes cannot be aligned with acceptable final appearance.
- N. Splice members only where indicated.
- O. Obtain permission for any torch cutting or field fabrication from the Architect. Finish sections thermally cut during erection to a surface appearance consistent with the mock up.

3.04 ERECTION AESS 2

- A. Erect to the requirements of 3.3 and as follows.
- B. AESS Erection Tolerances: Erect to standard frame tolerances for structural steel per Chapter 7 of ANSI/AISC 303-16.

3.05 ERECTION AESS 3

- A. Erect to the requirements of 3.4 and as follows.
- B. Field Welding: Weld profile, quality, and finish shall be consistent with mock-ups approved prior to fabrication.
- C. Provide a continuous appearance to all welded joints including tack welds. Provide joint filler at intermittent welds.

3.06 ERECTION AESS 4

- A. Erect to the requirements of 3.5 and as follows.
- B. Welds ground smooth: Erector shall grind welds smooth.
- C. Minimize Weld Show Through: At locations where welding on the far side of an exposed connection creates distortion, grind distortion and marking of the steel to a smooth profile with adjacent material.
- D. Filling of weld access holes: Where holes must be cut in the web at the intersection with flanges on W shapes and structural tees to permit field welding of the flanges, they shall be filled with joint filler.
- E. Where welds are indicated to be ground, contoured, or blended, oversize welds as required and grind to provide a smooth transition and match profile on approved mock-up.

3.07 ERECTION AESS C

- A. Not Used.

3.08 FIELD QUALITY CONTROL AND QUALITY ASSURANCE AESS 1 AND 2

- A. Structural requirements:

1. Conform to Quality Control requirements per ANSI/AISC 360-16 “Specification for Structural Steel Buildings” Chapter N and ANSI/AISC 303-16,” Code of Standard Practice for Steel Buildings and Bridges”, Section 10. Refer to Section 05 12 00 “Structural Steel” for additional requirements.
 2. Owner will engage a Quality Assurance agency per the requirements of ANSI/AISC 360-16 “Specification for Structural Steel Buildings” Chapter N and ANSI/AISC 303-16,” Code of Standard Practice for Steel Buildings and Bridges”, Section 10
- B. AESS acceptance: The Architect shall observe the AESS steel in place and determine acceptability based on the qualification data and submittals. The Quality Assurance Agency shall have no responsibility for enforcing the requirements of this section.

3.09 FIELD QUALITY CONTROL AESS 3, 4, AND C

- A. Conform to 3.7 and as follows.
- B. AESS acceptance: The Architect shall observe the AESS steel in place and determine acceptability based on the approved mock up. The Quality Assurance Agency shall have no responsibility for enforcing the requirements of this section.

3.10 ADJUSTING AND CLEANING

- A. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint shall be completed to blend with the adjacent surfaces of AESS. Such touch up work shall be done in accordance with manufacturer's instructions and as specified in Division 9, Section “Painting.”
- B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded area. Any repairs to galvanized surfaces shall comply with ASTM A780/A780M – 2015 Standard Practice for Repair of Damaged and Uncoated Areas of Hot Dip Galvanized Coatings.

END OF SECTION 05 12 13

SECTION 053100
STEEL DECKING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Roof deck.

B. Related Requirements:

1. Section 011100 "Summary of Work" for all Buy America Build America Act (BABA) requirements.
2. Section 033000 "Cast-in-Place Concrete" for normal-weight and lightweight structural concrete fill over steel deck.
3. Section 035216 "Lightweight Insulating Concrete" for lightweight insulating concrete fill over steel deck.
4. Section 051200 "Structural Steel Framing" for shop- and field-welded shear connectors.
5. Section 055000 "Metal Fabrications" for framing deck openings with miscellaneous steel shapes.

1.02 ACTION SUBMITTALS

A. Product Data:

1. Roof deck.

B. Shop Drawings:

1. Include layout and types of deck panels, anchorage details, reinforcing channels, pans, cut deck openings, special jointing, accessories, and attachments to other construction.

1.03 INFORMATIONAL SUBMITTALS

A. Certificates:

1. Product Certificates: For each type of steel deck.

B. Qualification Statements: For welding personnel and testing agency.

1.04 QUALITY ASSURANCE

- A. FM Approvals' RoofNav Listing: Provide steel roof deck evaluated by FM Approvals and listed in its "RoofNav" for Class 1 fire rating and Class 1-90 windstorm ratings. Identify

materials with FM Approvals Certification markings.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Protect steel deck from corrosion, deformation, and other damage during delivery, storage, and handling.
- B. Store products in accordance with SDI MOC3. Stack steel deck on platforms or pallets and slope to provide drainage. Protect with a waterproof covering and ventilate to avoid condensation.
 - 1. Protect and ventilate acoustical cellular roof deck with factory-installed insulation to maintain insulation free of moisture.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. AISI Specifications: Comply with calculated structural characteristics of steel deck in accordance with AISI S100.
- B. Fire-Resistance Ratings: Comply with ASTM E119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Indicate design designations from UL's "Fire Resistance Directory" or from listings of another qualified testing agency.

2.02 ROOF DECK

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. New Millennium Building Systems, LLC.
 - 2. Nucor Corporation.
 - 3. Nucor Corporation, Vercor Group.
 - 4. Vulcraft; Nucor Corporation, Vercor Group.
- B. Roof Deck: Fabricate panels, without top-flange stiffening grooves, to comply with SDI RD and with the following:
 - 1. Galvanized- and Shop-Primed Steel Sheet: ASTM A653/A653M, Structural Steel (SS), Grade 80, G60 zinc coating; cleaned, pretreated, and primed with manufacturer's standard baked-on, rust-inhibitive primer.
 - a. Color: Manufacturer's standard .
 - 2. Deck Profile: As indicated .
 - 3. Profile Depth: As indicated .

4. Design Uncoated-Steel Thickness: As indicated.
5. Design Uncoated-Steel Thicknesses; Deck Unit/Bottom Plate: As indicated.
6. Span Condition: As indicated.
7. Side Laps: Overlapped.

2.03 ACCESSORIES

- A. Provide manufacturer's standard accessory materials for deck that comply with requirements indicated.
- B. Mechanical Fasteners: Corrosion-resistant, low-velocity, power-actuated or pneumatically driven carbon-steel fasteners; or self-drilling, self-threading screws.
- C. Side-Lap Fasteners: Corrosion-resistant, hexagonal washer head; self-drilling, carbon-steel screws, No. 10 minimum diameter.
- D. Miscellaneous Sheet Metal Deck Accessories: Steel sheet, minimum yield strength of 80,000 psi, not less than 0.0359-inch design uncoated thickness, of same material and finish as deck; of profile indicated or required for application.
- E. Galvanizing Repair Paint: ASTM A780/A780M SSPC-Paint 20 or MIL-P-21035B, with dry film containing a minimum of 94 percent zinc dust by weight.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine supporting frame and field conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION, GENERAL

- A. Install deck panels and accessories in accordance with SDI C, SDI NC, and SDI RD, as applicable; manufacturer's written instructions; and requirements in this Section.
- B. Install temporary shoring before placing deck panels if required to meet deflection limitations.
- C. Locate deck bundles to prevent overloading of supporting members.
- D. Place deck panels on supporting frame and adjust to final position with ends accurately aligned and bearing on supporting frame before being permanently fastened. Do not stretch or contract side-lap interlocks.
 1. Align cellular deck panels over full length of cell runs and align cells at ends of abutting panels.

- E. Place deck panels flat and square and fasten to supporting frame without warp or deflection.
- F. Cut and neatly fit deck panels and accessories around openings and other work projecting through or adjacent to deck.
- G. Provide additional reinforcement and closure pieces at openings as required for strength, continuity of deck, and support of other work.
- H. Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used for correcting welding work.
- I. Mechanical fasteners may be used in lieu of welding to fasten deck. Locate mechanical fasteners and install in accordance with deck manufacturer's written instructions.

3.03 INSTALLATION OF ROOF DECK

- A. Fasten roof-deck panels to steel supporting members by hilti pins as noted in the drawings. Contractors option in lieu of pins to use arc spot (puddle) welds of the surface diameter indicated or arc seam welds with an equal perimeter that is not less than 1-1/2 inches long, and as follows:
 - 1. Weld Diameter: 5/8 inch , nominal.
 - 2. Weld Spacing: Weld edge and interior ribs of deck units with a minimum of two welds per deck unit at each support. Space welds at 36/7 apart in Zone A and at 36/7 apart in Zones B, based on roof-area definitions in FM Global Loss Prevention Data Sheet 1-28 as indicated.
 - 3. Weld Washers: Install weld washers at each weld location.
- B. Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports, at intervals not exceeding the lesser of one-half of the span or 18 inches, and as follows:
 - 1. Mechanically fasten with self-drilling, No. 10 diameter or larger, carbon-steel screws.
 - 2. Mechanically clinch or button punch.
 - 3. Fasten with a minimum of 1-1/2-inch- long welds.
- C. End Bearing: Install deck ends over supporting frame with a minimum end bearing of 1-1/2 inches, with end joints as follows:
 - 1. End Joints: Lapped 2 inches minimum.
- D. Roof Sump Pans and Sump Plates: Install over openings provided in roof deck and mechanically fasten flanges to top of deck. Space mechanical fasteners not more than 12 inches apart with at least one fastener at each corner.
 - 1. Install reinforcing channels or zees in ribs to span between supports and weld.

- E. Miscellaneous Roof-Deck Accessories: Install ridge and valley plates, finish strips, end closures, and reinforcing channels in accordance with deck manufacturer's written instructions. Weld to substrate to provide a complete deck installation.
 - 1. Weld cover plates at changes in direction of roof-deck panels unless otherwise indicated.
- F. Flexible Closure Strips: Install flexible closure strips over partitions, walls, and where indicated. Install with adhesive in accordance with manufacturer's written instructions to ensure complete closure.
- G. Sound-Absorbing Insulation: Installation into topside ribs of deck as specified in .

3.04 INSTALLATION OF FLOOR DECK

- A. Fasten floor-deck panels to steel supporting members by arc spot (puddle) welds of the surface diameter indicated and as follows:
 - 1. Weld Diameter: 5/8 inch, nominal.
 - 2. Weld Spacing:
 - a. Weld edge ribs of panels at each support. Space additional welds an average of 16 inches apart, but not more than 18 inches apart.
 - b. Space and locate welds as indicated.
 - 3. Weld Washers: Install weld washers at each weld location.
- B. Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports, at intervals not exceeding the lesser of one-half of the span or 36 inches, and as follows:
 - 1. Mechanically fasten with self-drilling, No. 10 diameter or larger, carbon-steel screws.
 - 2. Mechanically clinch or button punch.
 - 3. Fasten with a minimum of 1-1/2-inch- long welds.
- C. End Bearing: Install deck ends over supporting frame with a minimum end bearing of 1-1/2 inches, with end joints as follows:
 - 1. End Joints: Lapped.
- D. Pour Stops and Girder Fillers: Weld steel sheet pour stops and girder fillers to supporting structure in accordance with SDI recommendations unless otherwise indicated.
- E. Floor-Deck Closures: Weld steel sheet column closures, cell closures, and Z-closures to deck, in accordance with SDI recommendations, to provide tight-fitting closures at open ends of ribs and sides of deck.

- F. Electrified Cellular Floor Deck: Install cellular floor system with deck assembled from .
- G. Coordinate layout and installation of trench headers, preset inserts, duct fittings, and other components specified in Section 260539 "Underfloor Raceways for Electrical Systems" with installation of electrified cellular metal floor deck.
- H. Install piercing hanger tabs at 14 inches apart in both directions, within 9 inches of walls at ends, and not more than 12 inches from walls at sides unless otherwise indicated.

3.05 REPAIR

- A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on both surfaces of deck with galvanized repair paint in accordance with ASTM A780/A780M and manufacturer's written instructions.
- B. Repair Painting:
 - 1. Wire brush and clean rust spots, welds, and abraded areas on both surfaces of prime-painted deck immediately after installation, and apply repair paint.
 - 2. Apply repair paint, of same color as adjacent shop-primed deck, to bottom surfaces of deck exposed to view.
 - 3. Wire brushing, cleaning, and repair painting of bottom deck surfaces are included in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."
 - 4. Wire brushing, cleaning, and repair painting of rust spots, welds, and abraded areas of both deck surfaces are included in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

3.06 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Tests and Inspections:
 - 1. Steel decking will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

END OF SECTION 053100

SECTION 06 10 00
ROUGH CARPENTRY

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes, but is not limited to, rough carpentry for:
 - 1. Wood grounds, nailers, and blocking.
 - 2. Plywood panel surfacing.
 - 3. Decay and termite resistant wood treatment.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00:
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) Requirements
- B. PRECAST STRUCTURAL CONCRETE: Section 03 41 00.
- C. ROOF AND DECK INSULATION: Section 07 22 00.
- D. STANDING SEAM METAL ROOF PANELS: Section 07 41 13.
- E. FORMED METAL WALL PANELS: SECTION 07 42 13.13
- F. SHEET METAL FLASHING AND TRIM: Section 07 62 00.
- G. PAINTING: Section 09 91 00.

1.03 QUALITY ASSURANCE

- A. Reference Standards: Comply with provisions of the following, unless otherwise indicated or specified:
 - 1. American Forest & Paper Association (AFPA):
 - a. Manual for Wood Frame Construction.
 - 2. American Lumber Standards Committee (ALSC):
 - a. Board of Review.
 - 3. APA - The Engineered Wood Association (APA):
 - a. APA Standard Grading Rules.
 - b. Form No. E30K - APA Design/Construction Guide: Residential &

Commercial.

4. American Society for Testing and Materials (ASTM):
 - a. Reference Standards.
5. American Wood Preservers' Association (AWPA):
 - a. Reference Standards.
6. Federal Specifications (FS):
 - a. Reference Standards.
7. U.S. Owner of Commerce (DOC), National Institute of Standards and Technology:
 - a. Referenced Product Standards (PS).
8. Southern Pine Inspection Bureau (SPIB):
 - a. SPIB Standard Grading Rules.
9. West Coast Lumber Inspection Bureau (WCLIB):
 - a. WCLIB Standard Grading Rules.
10. Western Wood Products Association (WWPA):
 - a. WWPA Standard Grading Rules.
 - b. Recommended Nailing Schedule.

1.04 SUBMITTALS

- A. Product Data for Treated Lumber: Submit treatment plant's data showing the lumber type, certification by the treating plant stating chemicals and process used, net amount of treatment retained, and conformance with applicable standards. Include a statement that moisture content of treated materials was reduced to a maximum of 19 percent prior to shipment to the Site.
- B. Calculations: Provide calculations for the type, size, length and minimum embedment depth of fasteners required for wood furring and plywood walls used to support the wall mounted equipment. Calculations shall be signed and sealed by a professional engineer currently registered in the State of Florida.

1.05 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Maintain materials under cover and dry. Protect against exposure to weather and contact with damp or wet surfaces. Stack lumber as well as plywood and other panels; provide for air circulation within and around stacks and under temporary coverings including

polyethylene and similar materials.

- B. For lumber and plywood pressure treated with waterborne chemicals, provide space between each course to provide air circulation.

1.06 PROJECT CONDITIONS

- A. Coordination: Fit carpentry work to other work; scribe and cope as required for accurate fit. Correlate location of furring, nailers, plates, blocking, grounds and similar supports to allow attachment of other work.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Lumber Standards, General:

1. Manufacture lumber to comply with DOC PS 20 "American Softwood Lumber Standard" and with applicable grading rules of inspection agencies certified by ALSC Board of Review.
2. Factory mark each piece of lumber with grade stamp of inspection agency evidencing compliance with grading rule requirements and identifying grading agency, grade species, moisture content at time of surfacing, and mill.
3. Nominal sizes are indicated, except as shown by detail dimensions. Provide actual sizes as required by DOC PS 20, for moisture content specified for each use.
4. Provide seasoned lumber with 19 percent maximum moisture content at time of dressing and shipment for sizes 2 inches or less in nominal thickness, unless otherwise indicated.
5. Fire retardant treated, pressure impregnated kiln dried, third party tested with certification label, flame spread less than 25 per ASTM E84.

- B. Grounds, Blocking, Nailers, Blocking, and Similar Members:

1. Grounds, nailers, blocking, and similar members shall be standard grade light framing size lumber of any species or board size lumber as required. No. 2 Common or Standard grade boards per WCLIB or WWPA rules, or No. 2 boards per SPIB rules.

- C. Plywood Panels:

1. Comply with DOC PS 1 "U.S. Product Standard for Construction and Industrial Plywood" for plywood panels and, for products not manufactured under PS 1 provisions, with APA Form No. E30K.
2. Factory mark each construction panel with APA trademark evidencing

compliance with grade requirements.

3. Where construction panels are used for the following concealed types of applications, provide APA Performance-Rated Panels complying with requirements indicated for grade designation, span rating, exposure durability classification, and thickness.

D. Fasteners and Anchorages:

1. Provide size, type, material, and finish as indicated and as recommended by applicable standards, complying with applicable Federal Specifications for nails, staples, screws, bolts, nuts, washers, and anchoring devices. Provide metal hangers and framing anchors of the size and type recommended by the manufacturer for each use including recommended nails.
2. Where rough carpentry is exposed to weather, in ground contact, or in area of high relative humidity, provide fasteners and anchorages with a hot-dip zinc coating pursuant to ASTM A 153.
3. Stainless steel as identified in drawings.

E. Decay and Termite Resistant Wood Treatment:

1. All lumber and plywood specified for decay and termite resistant treatment shall be pressure treated according to AWWA Standard P-5 and FS TT-W-550. Preservatives containing arsenic are NOT acceptable.
2. Products: Provide one of the following treatments:
 - a. "Natural Select" copper azole preservative; Arch Wood Protection, Inc.
 - b. "Preserve" ACQ; Chemical Specialties, Inc.
 - c. "Nature Wood"; Osmose Wood Preserving Co., Inc.

2.02 WOOD TREATMENT

A. Decay and Termite Resistant Wood Treatment:

1. Chemicals shall be applied in a closed cylinder by vacuum-pressure in strict accordance with manufacturer's instructions and with the approved standards and recommended treating practices as listed in AWWA Standards C2 and C9 or the appropriate AWWA standard covering the commodity treated and as listed in FS TT-W-571.
 - a. After treatment and before shipment, lumber 2" nominal or less shall be dried to a 15-19 percent moisture content.
 - b. Plywood shall be dried after treatment and before shipment to moisture content of 18 percent or less.

B. Provide decay (termite) and fire treatment of the following lumber:

<u>Location</u>	<u>Treatment (General)</u>
Wood members in contact with concrete, used in connection with roofing, furring for interior plywood panels on ceiling and walls, or exposed to moisture	Decay (Termite)

PART 3 - EXECUTION

3.01 INSPECTION

- A. Examine the areas and conditions under which rough carpentry work is to be installed. Do not proceed with rough carpentry work until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. General:

1. Material with defects, which might impair the quality of the work, and units which are too small to fabricate with a minimum of joints or the optimum joint arrangement, shall be discarded.
2. All rough carpentry work shall be set accurately to required levels and lines, with members plumb and true, and accurately cut and fitted.
3. All rough carpentry work shall be securely attached to substrates by anchoring and fastening as shown, and as required for structural adequacy.
4. Fasteners shall be of size that will not penetrate members where opposite side will be exposed to view or will receive finish materials. Tight connections shall be made. Fasteners shall be installed without splitting of wood; predrill as required.
5. Use washers where required for fasteners to avoid movement of material through loading and/or vibration.
6. Seal cut ends where exposed to moisture or where moisture could migrate via gravity, capillary action, expansion or pressure gradients.

B. Wood Grounds, Nailers, and Blocking:

1. Wood grounds, nailers, and blocking shall be installed where indicated on the Plans, and wherever required for screeding or attachment of other work. Shapes shall be formed as shown and cut as required for true line and level of work to be attached.
2. Attach to substrates as required to support applied loading. Countersink bolts and nuts flush with surfaces, unless otherwise indicated. Build into masonry

during installation of masonry work. Where possible, anchor to formwork prior to concrete placement.

C. Plywood Panels:

1. Comply with applicable recommendations contained in APA Form No. E 30K for types of plywood panels and applications indicated.
2. Fastening Methods: Fasten panels as follows, in strict accordance with the Florida Building Code:
 - a. Backing Panels: Screw to supports, as applicable.
3. Install with joints butted flush and smooth out all fasteners. The fasteners shall be countersunk, flush with the plywood surface and concealed with wood filler and lightly sanded to produce a smooth, uniform finish.

END OF SECTION 06 10 00

SECTION 06 40 23
INTERIOR ARCHITECTURAL WOODWORK

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Interior standing and running trim.
2. Wood furring, blocking, shims, and hanging strips for installing interior architectural woodwork items that are not concealed within other construction.
3. Shop priming of interior architectural woodwork.
4. Shop finishing of interior architectural woodwork.

1.02 RELATED WORK

A. SUMMARY OF WORK: Section 01 11 00:

1. Refer to "PART 2 – PRODUCTS" for all Buy America Build America Act (BABA) Requirements

B. ROUGH CARPENTRY: Section 06 10 00.

C. PAINTING: Section 09 91 00.

D. QUARTZ AGGLOMERATE COUNTERTOPS: Section 12 36 61.

1.03 SUBMITTALS

A. Product Data: For the following:

1. Anchors.
2. Adhesives.
3. Shop finishing materials.
4. Fire-Retardant Treatment (as applicable): Include data and warranty information from chemical-treatment manufacturer and certification by treating plant that treated materials comply with requirements.

B. Shop Drawings:

1. Include the following:
 - a. Dimensioned plans, elevations, and sections.
 - b. Attachment details.

2. Show large-scale details.
 3. Show locations and sizes of furring, blocking, and hanging strips, including blocking and reinforcement concealed by construction and specified in other Sections.
- C. Samples: For each exposed product and for each shop-applied color and finish specified.
- D. Qualification Data: For architectural woodwork manufacturer and Installer.
- E. Product Certificates: For the following:
1. Composite wood and agrifiber products.
 2. Adhesives.
 3. Field quality-control reports.

1.04 FIELD CONDITIONS

1. Environmental Limitations: Do not deliver or install interior architectural woodwork until building is enclosed, wet-work is complete, and HVAC system is operating and maintaining temperature and relative humidity at levels designed for building occupants for the remainder of the construction period.

PART 2 - PRODUCTS

2.01 ARCHITECTURAL WOODWORK, GENERAL

- A. Quality Standard: Unless otherwise indicated, comply with the Architectural Woodwork Standards for grades of interior architectural woodwork indicated for construction, finishes, installation, and other requirements.

2.02 INTERIOR STANDING AND RUNNING TRIM FOR TRANSPARENT FINISH

- A. Architectural Woodwork Standards Grade: Custom.
- B. Hardwood Lumber:
1. Species: As indicated on Plans or selected by Engineer.
 2. Cut: Plain sliced/plain sawn
 3. Wood Moisture Content: 8 to 13 percent.
 4. For rails thicker than available lumber, use veneered construction. Do not glue for thickness.
 5. For trim items wider than available lumber, use veneered construction. Do not glue for width.
- C. Softwood Lumber:

1. Species: As indicated on Plans or selected by Engineer.
2. Cut: Plain sawn.
3. Wood Moisture Content: 8 to 13.
4. Provide split species on trim that faces areas with different wood species, matching each face of woodwork to species and cut of finish wood surfaces in areas finished.
5. For trim items wider than available lumber, use veneered construction. Do not glue for width.
6. For base wider than available lumber, glue for width. Do not use veneered construction.
7. For rails thicker than available lumber, use veneered construction. Do not glue for thickness.
8. Do not use plain-sawn softwood lumber with exposed, flat surfaces more than 3 inches wide.

2.03 INTERIOR STANDING AND RUNNING TRIM FOR OPAQUE FINISH

- A. Architectural Woodwork Standards Grade: Custom.
 1. Wood Species: As indicated on Plans or selected by Engineer.
 2. Wood Moisture Content: 8 to 13 percent.

2.04 HARDWOOD SHEET MATERIALS

- A. Composite Wood and Agrifiber Products: Provide materials that comply with requirements of the Architectural Woodwork Standards for each type of interior architectural woodwork and quality grade specified unless otherwise indicated.
 1. Medium-Density Fiberboard (MDF): ANSI A208.2, Grade 130.
 2. Particleboard: ANSI A208.1, Grade M-2-Exterior Glue.
 3. Softwood Plywood: DOC PS 1, medium-density overlay.
 4. Veneer-Faced Panel Products (Hardwood Plywood): HPVA HP-1.
 - a. Interior Wall and casework panels: Provide plywood panels with marine-grade designation, APA A-B non-fire rated, with A side finish facing the interior of the building, in minimum 3/4 inch thickness with a stainable surface, unless otherwise indicated.
 - b. Class C interior finish in accordance with ASTM E84 or UL 723.
 - (1) Flame spread index: 76-20

(2) Smoke developed: 0-450

2.05 FIRE-RETARDANT-TREATED WOOD MATERIALS

- A. Fire-Retardant-Treated Wood Materials: Where fire-retardant-treated materials are indicated, use materials complying with requirements that are acceptable to authorities having jurisdiction and with fire-test-response characteristics specified as determined by testing identical products according to test method indicated by a qualified testing agency.
1. Use treated materials that comply with requirements of the Architectural Woodwork Standards. Do not use materials that are warped, discolored, or otherwise defective.
 2. Use fire-retardant-treatment formulations that do not bleed through or otherwise adversely affect finishes. Do not use colorants to distinguish treated materials from untreated materials.
 3. Identify fire-retardant-treated materials with appropriate classification marking of qualified testing agency in the form of removable paper label or imprint on surfaces that will be concealed from view after installation.
- B. Fire-Retardant-Treated Lumber and Plywood: Products with a flame-spread index of 25 or less when tested according to ASTM E84, with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet beyond the centerline of the burners at any time during the test.
1. Kiln-dry lumber and plywood after treatment to a maximum moisture content of 19 and 15 percent, respectively.

2.06 MISCELLANEOUS MATERIALS

- A. Furring, Blocking, Shims, and Nailers: Softwood or hardwood lumber, Fire-retardant-treated softwood lumber, kiln-dried to less than 15 percent moisture content.
1. Preservative Treatment: Provide softwood lumber treated by pressure process, AWPA U1; Use Category UC3b.
 - a. Provide where in contact with concrete or masonry.
 - b. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent.
 - c. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.
 - d. Mark lumber with treatment quality mark of an inspection agency approved by the American Lumber Standards Committee's (ALSC) Board of Review.

2. Fire-Retardant Treatment: Complying with requirements; provide where indicated or required.
- B. Provide self-drilling screws for metal-framing supports, as recommended by metal-framing manufacturer.
- C. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage.
 1. Provide metal expansion sleeves or expansion bolts for post-installed anchors.
 2. Use nonferrous-metal or hot-dip galvanized anchors and inserts at inside face of exterior walls and at floors.
- D. Installation Adhesive: Product recommended by fabricator for each substrate for secure anchorage.

2.07 FABRICATION

- A. Sand fire-retardant-treated wood lightly to remove raised grain on exposed surfaces before fabrication.
- B. Fabricate interior architectural woodwork to dimensions, profiles, and details indicated.
 1. Ease edges to radius indicated for the following:
 - a. Edges of Solid-Wood (Lumber) Members: 1/16 inch unless otherwise indicated.
 - b. Edges of Rails and Similar Members More Than 3/4 Inch Thick: 1/8 inch.
- C. Complete fabrication, including assembly, to maximum extent possible before shipment to Project site.
 1. Disassemble components only as necessary for shipment and installation.
 2. Where necessary for fitting at site, provide allowance for scribing, trimming, and fitting.
 3. Trial fit assemblies at fabrication shop that cannot be shipped completely assembled.
 - a. Install dowels, screws, bolted connectors, and other fastening devices that can be removed after trial fitting.
 - b. Verify that parts fit as intended, and check measurements of assemblies against field measurements indicated on approved Shop Drawings before disassembling for shipment.

2.08 SHOP PRIMING

- A. Preparations for Finishing: Comply with the Architectural Woodwork Standards for sanding, filling countersunk fasteners, sealing concealed surfaces, and similar preparations for finishing interior architectural woodwork, as applicable to each unit of work.
- B. Interior Architectural Woodwork for Opaque Finish: Shop prime with one coat of wood primer as specified in Section 09 91 00 - PAINTING.
 - 1. Backpriming: Apply one coat of primer, compatible with finish coats, to concealed surfaces of woodwork. Apply two coats to surfaces installed in contact with concrete or masonry and to end-grain surfaces.
- C. Interior Architectural Woodwork for Transparent Finish: Shop-seal concealed surfaces with required pretreatments and first coat of finish as specified in Section 09 91 00 - PAINTING.
 - 1. Backpriming: Apply one coat of sealer, compatible with finish coats, to concealed surfaces of woodwork. Apply two coats to surfaces installed in contact with concrete or masonry and to end-grain surfaces.

2.09 SHOP FINISHING

- A. Finish interior architectural woodwork as indicated on Plans at fabrication shop. Defer only final touchup, cleaning, and polishing until after installation.
- B. Preparation for Finishing: Comply with Architectural Woodwork Standards, Section 5 for sanding, filling countersunk fasteners, sealing concealed surfaces, and similar preparations for finishing interior architectural woodwork, as applicable to each unit of work.
- C. Backpriming: Apply one coat of sealer or primer, compatible with finish coats, to concealed surfaces of interior architectural woodwork. Apply two coats to end-grain surfaces.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Before installation, condition interior architectural woodwork to humidity conditions in installation areas for not less than 72 hours prior to beginning of installation.
- B. Before installing interior architectural woodwork, examine shop-fabricated work for completion and complete work as required, including removal of packing and backpriming of concealed surfaces.

3.02 INSTALLATION

- A. Grade: Install interior architectural woodwork to comply with same grade as item to be installed.

- B. Assemble interior architectural woodwork and complete fabrication at Project site to the extent that it was not completed during shop fabrication.
- C. Install interior architectural woodwork level, plumb, true in line, and without distortion.
 - 1. Shim as required with concealed shims.
 - 2. Install level and plumb to a tolerance of 1/8 inch in 96 inches.
- D. Scribe and cut interior architectural woodwork to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.
- E. Preservative-Treated Wood: Where cut or drilled in field, treat cut ends and drilled holes according to AWPA M4.
- F. Fire-Retardant-Treated Wood: Install fire-retardant-treated wood to comply with chemical treatment manufacturer's written instructions, including those for adhesives used to install woodwork.
- G. Anchor interior architectural woodwork to anchors or blocking built in or directly attached to substrates.
 - 1. Secure with countersunk, concealed fasteners and blind nailing.
 - 2. Use fine finishing nails or finishing screws for exposed fastening, countersunk and filled flush with interior architectural woodwork.
 - 3. For shop-finished items, use filler matching finish of items being installed.
- H. Standing and Running Trim:
 - 1. Install with minimum number of joints possible, using full-length pieces (from maximum length of lumber available) to greatest extent possible.
 - 2. Do not use pieces less than **60 inches** long, except where shorter single-length pieces are necessary.
 - 3. Scarf running joints and stagger in adjacent and related members.
 - 4. Filling with wood filler is more labor intensive than filling with latex sealant.
 - 5. Install standing and running trim with no more variation from a straight line than 1/8 inch in 96 inches.

END OF SECTION 06 40 23

SECTION 07 13 20
SELF-ADHERING SHEET UNDERLAYMENT

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes self-adhering sheet underlayment applied to roof composite insulation board for standing seam metal roof panels as indicated on the Plans.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00:
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) Requirements
- B. ROOF AND DECK INSULATION: Section 07 22 00.
- C. STANDING SEAM METAL ROOF PANELS: Section 07 41 13.
- D. FORMED METAL WALL PANELS: SECTION 07 42 13.13.
- E. SHEET METAL FLASHING AND TRIM: SECTION 07 62 00.

1.03 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples for Verification: For the following products, of sizes indicated, to verify color selected.
 - 1. Self-Adhering Underlayment: 12 inches square.

1.04 QUALITY ASSURANCE

- A. Source Limitations: Obtain self-adhering sheet underlayment through one source from a single underlayment manufacturer.
- B. Fire-Test-Response Classification: Provide underlayment with the fire-test-response characteristics indicated, as determined by testing identical products per test method below by UL or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify materials with appropriate markings of applicable testing and inspecting agency.
 - 1. Exterior Fire-Test Exposure: Class A; ASTM E 108, or UL 790, for application and roof slopes indicated.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Store underlayment rolls on end on pallets or other raised surfaces. Do not double-stack rolls.

1. Handle, store, and place materials in a manner to avoid significant or permanent damage to roof deck or structural supporting members.
- B. Protect unused underlayment from weather, sunlight, and moisture when left overnight or when roofing work is not in progress.

1.06 PROJECT CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit underlayment work to be performed according to manufacturer's written instructions and warranty requirements.
 1. Install self-adhering sheet underlayment within the range of ambient and substrate temperatures recommended by manufacturer.

PART 2 - PRODUCTS

2.01 UNDERLAYMENT MATERIALS

- A. Self-Adhering Sheet Underlayment, Polyethylene Faced: ASTM D 1970, minimum of 40 mil thick, slip-resisting, polyethylene-film-reinforced top surface laminated to SBS-modified asphalt adhesive, with release paper backing; cold applied. Provide primer for adjoining concrete or masonry surfaces to receive underlayment.
 1. As required by roofing system product approval.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of Work.
 1. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and completely anchored.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 UNDERLAYMENT INSTALLATION

- A. Install self-adhering sheet underlayment in accordance with manufacturer's written instructions. Install at locations indicated on Plans, lapped in direction to shed water. Lap sides not less than 3-1/2 inches. Lap ends not less than 6 inches staggered 24 inches between courses. Roll laps with roller. Cover underlayment within seven days.

END OF SECTION 07 13 20

SECTION 07 21 00
THERMAL INSULATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. SUMMARY OF WORK: Section 01 11 00:

1. Refer to "PART 2 – PRODUCTS" for all Buy America Build America Act (BABA) Requirements .

1.02 SUMMARY

A. Section Includes:

1. Polyisocyanurate foam-plastic board.
2. Glass Fiber Blanket

B. Related Requirements:

1. Section 09 29 00 "Gypsum Board" for sound attenuation blanket used as acoustic insulation.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Low-emitting product certification.

1.04 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For each product, for tests performed by a qualified testing agency.

B. Evaluation Reports: For foam-plastic insulation, from ICC-ES.

1.05 QUALITY ASSURANCE

A. Surface-Burning Characteristics: as determined by testing identical products according to ASTM E 84 by qualified testing agency. Identify products with the appropriate markings of applicable test agency.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Protect insulation materials from physical damage and from deterioration due to moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.

B. Protect foam-plastic board insulation as follows:

1. Do not expose to sunlight except to necessary extent for period of installation and

concealment.

2. Protect against ignition at all times. Do not deliver foam-plastic board materials to Project site until just before installation time.
3. Quickly complete installation and concealment of foam-plastic board insulation in each area of construction.

PART 2 - PRODUCTS

2.01 POLYISOCYANURATE FOAM-PLASTIC BOARD

- A. Polyisocyanurate Board, Foil-Faced, Polyisocyanurate Board Insulation: ASTM C 1289, Type I, foil-faced on both sides, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, based on tests performed on unfaced core on thicknesses up to 4 inches.
- B. R-value: 5.7 per cubic inch

2.02 REFLECTIVE INSULATIONS

- A. Sheet Radiant Barrier: ASTM C 1313/C 1313M with at least one surface with emittance value of 0.1 or less as measured per ASTM C 1371.
 1. Construction: Foil on one side of substrate.
 2. Surface-Burning Characteristics: Maximum flame-spread and smoke-developed indexes of 5 and 10 respectively.
 3. Water-Vapor Transmission: 1 perm, maximum.

2.03 VAPOR RETARDERS

- A. Polyethylene Vapor retarders: ASTM D 4397, 6 mils (0.15 mm) with maximum permeance rating of 0.13 perm (7.5 ng/PA x s x sq. m)
- B. Vapor-Retarder Tape: Pressure-sensitive tape of type recommended by vapor-retarder manufacturer for sealing joints and penetrations in vapor retarder.
- C. Vapor-Retarder fasteners: Pancake-head self-tapping steel drill screws; with fender washers.
- D. Single-Component Non-sag, Urethane Sealant: ASTM C920, Type I, Grade NS, Class 25, Use NT related to exposure, and use O related to vapor-barrier-related substrates.
- E. Adhesive for Vapor Retarders: Product recommended by vapor-retarder manufacturer and has demonstrated capability to bond vapor retarders securely to substrates indicated.

2.04 INSULATION FASTENERS

- A. Adhesively Attached, Spindle-Type Anchors: Plate welded to projecting spindle; capable of holding insulation of specified thickness securely in position with self-locking washer

in place.

1. Plate: Perforated, galvanized carbon-steel sheet, 0.030 inch (0.762 mm) thick by 2 inches (50 mm) square.
 2. Spindle: Copper-coated, low-carbon steel; fully annealed; 0.105 inch (2.67 mm) in diameter; length to suit depth of insulation.
- B. Adhesively Attached, Angle-Shaped, Spindle-Type Anchors: Angle welded to projecting spindle; capable of holding insulation of specified thickness securely in position with self-locking washer in place.
1. Manufacturers:
 - a. Gemco: 90-degree Insulation hangers.
 2. Angle: Formed from 0.030-inch- (0.762-mm-) thick, perforated, galvanized carbon-steel sheet with each leg 2 inches (50 mm) square.
 3. Spindle: Copper-coated, low-carbon steel; fully annealed; 0.105 inch (2.67 mm) in diameter; length to suit depth of insulation.
- C. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- (0.41-mm-) thick galvanized-steel sheet, with beveled edge for increased stiffness, sized as required to hold insulation securely in place, but not less than 1-1/2 inches (38 mm) square or in diameter.
1. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in the following locations:
 - a. Crawl spaces.
 - b. Ceiling plenums.
 - c. Attic spaces.
- D. Anchor Adhesive: Product with demonstrated capability to bond insulation anchors securely to substrates without damaging insulation, fasteners, or substrates.

2.05 ACCESSORIES

- A. Insulation for Miscellaneous Voids:
1. Glass-Fiber Insulation: ASTM C 764, Type II, loose fill; with maximum flame-spread and smoke-developed indexes of 5, per ASTM E 84.
 2. Spray Polyurethane Foam Insulation: ASTM C 1029, Type II, closed cell, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, per ASTM E 84.
- B. Adhesive for Bonding Insulation: Product compatible with insulation and air and water barrier materials, and with demonstrated capability to bond insulation securely to substrates

without damaging insulation and substrates.

- C. Asphalt Coating for Cellular-Glass Block Insulation: Cutback asphalt or asphalt emulsion of type recommended by manufacturer of cellular-glass block insulation.
- D. Eave Ventilation Troughs: Preformed, rigid fiberboard or plastic sheets designed and sized to fit between roof framing members and to provide ventilation between insulated attic spaces and vented eaves.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Clean substrates of substances that are harmful to insulation, including removing projections capable of puncturing insulation or vapor retarders, or that interfere with insulation attachment.

3.02 INSTALLATION, GENERAL

- A. Comply with insulation manufacturer's written instructions applicable to products and applications.
- B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed to ice, rain, or snow at any time.
- C. Extend insulation to envelop entire area to be insulated. Fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.
- D. Provide sizes to fit applications and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units unless multiple layers are otherwise shown or required to make up total thickness or to achieve R-value.

3.03 INSTALLATION OF SLAB INSULATION

- A. On vertical slab edge and foundation surfaces, set insulation units using manufacturer's recommended adhesive according to manufacturer's written instructions.
 - 1. If not otherwise indicated, extend insulation a minimum of 36 inches (915 mm) below exterior grade line.
- B. On horizontal surfaces, loosely lay insulation units according to manufacturer's written instructions. Stagger end joints and tightly abut insulation units.
 - 1. If not otherwise indicated, extend insulation a minimum of 36 inches (915 mm) in from exterior walls.

3.04 INSTALLATION OF INSULATION IN FRAMED CONSTRUCTION

- A. Blanket Insulation: Install in cavities formed by framing members according to the following requirements:
 - 1. Use insulation widths and lengths that fill the cavities formed by framing members.

If more than one length is required to fill the cavities, provide lengths that will produce a snug fit between ends.

2. Place insulation in cavities formed by framing members to produce a friction fit between edges of insulation and adjoining framing members.
 3. Maintain 3-inch (76-mm) clearance of insulation around recessed lighting fixtures not rated for or protected from contact with insulation.
 4. Attics: Install eave ventilation troughs between roof framing members in insulated attic spaces at vented eaves.
 5. For metal-framed wall cavities where cavity heights exceed 96 inches (2438 mm), support unfaced blankets mechanically and support faced blankets by taping flanges of insulation to flanges of metal studs.
 6. For wood-framed construction, install blankets according to ASTM C 1320 and as follows:
 - a. With faced blankets having stapling flanges, lap blanket flange over flange of adjacent blanket to maintain continuity of vapor retarder once finish material is installed over it.
 7. Vapor-Retarder-Faced Blankets: Tape joints and ruptures in vapor-retarder facings, and seal each continuous area of insulation to ensure airtight installation.
 - a. Exterior Walls: Set units with facing placed toward as indicated on Drawings.
 - b. Interior Walls: Set units with facing placed as indicated on Drawings.
- B. Miscellaneous Voids: Install insulation in miscellaneous voids and cavity spaces where required to prevent gaps in insulation using the following materials:
1. Glass-Fiber Insulation: Compact to approximately 40 percent of normal maximum volume equaling a density of approximately 2.5 lb/cu. ft. (40 kg/cu. m).
 2. Spray Polyurethane Insulation: Apply according to manufacturer's written instructions.
- C. Loose-Fill Insulation: Apply according to ASTM C 1015 and manufacturer's written instructions. Level horizontal applications to uniform thickness as indicated, lightly settle to uniform density, but do not compact excessively.
1. For cellulosic-fiber loose-fill insulation, comply with CIMA's Bulletin #2, "Standard Practice for Installing Cellulose Insulation."
- D. Spray-Applied Cellulosic Insulation: Apply spray-applied insulation according to manufacturer's written instructions. Do not apply insulation until installation of pipes, ducts, conduits, wiring, and electrical outlets in walls is completed and windows, electrical boxes, and other items not indicated to receive insulation are masked. After insulation is applied,

make flush with face of studs by using method recommended by insulation manufacturer.

3.05 INSTALLATION OF CURTAIN-WALL INSULATION

- A. Install board insulation in curtain-wall construction according to curtain-wall manufacturer's written instructions.
 - 1. Hold insulation in place by securing metal clips and straps or integral pockets within window frames, spaced at intervals recommended in writing by insulation manufacturer to hold insulation securely in place without touching spandrel glass. Maintain cavity width of dimension indicated on Drawings between insulation and glass.
 - 2. Install insulation to fit snugly without bowing.

3.06 INSTALLATION OF REFLECTIVE INSULATION

- A. Install sheet reflective insulation according to ASTM C 727.
- B. Install sheet radiant barriers according to ASTM C 1744.
- C. Install interior radiation control coating system according to ASTM C 1321.

3.07 INSTALLATION OF INSULATION FOR CONCRETE SUBSTRATES

- A. Install board insulation on concrete substrates as adhesively attached, spindle-type insulation anchors as follows:
 - 1. Fasten insulation anchors to concrete substrates with insulation anchor adhesive according to manufacturer's written instructions. Space anchors according to insulation manufacturer's written instructions for the insulation type, thickness and application indicated.
 - 2. Apply insulation stand-offs to each spindle to create cavity width indicated between concrete substrate and insulation.
 - 3. After adhesive has dried, install board insulation by pressing insulation into position over spindles and securing it tightly in place with insulation-retaining washers, taking care not to compress insulation below indicated thickness.
 - 4. Where insulation will not be covered by other building materials, apply capped washers to spindle tips.

3.08 INSTALLATION OF VAPOR RETARDERS

- A. Place vapor retarders on the side of construction indicated on Drawings. Extend vapor retarders to extremities of areas to protect from vapor transmission. Secure vapor retarders in place with adhesives or other anchorage systems as indicated. Extend vapor retarders to cover miscellaneous voids in insulated substrates, including those with loose-fiber insulation.
- B. Seal vertical joints in vapor retarders over framing by lapping no fewer than two studs.

1. Fasten vapor retarders to framing at top, end, and bottom edges: at perimeter of wall openings; lap joints. Space fasteners 16 inches (406 mm) o.c.
 2. Before installing vapor retarders, apply urethane sealant to flanges of metal framing including runner track, metal studs, and framing around door and window openings. Seal overlapping joints with vapor retarders. Locate all joints over framing members or other solid surfaces.
- C. Seal joints caused pipes, conduits, electrical boxes, and similar items penetrating vapor retarders with vapor retarders tape to create an air tight seal between penetrating objects and vapor retarders.
- D. Repair tears or punctures in vapor retarders immediately before concealment by other work. Cover with vapor-retarder tape or another layer of vapor retarders.

3.09 PROTECTION

- A. Protect installed insulation from damage due to harmful weather exposures, physical abuse, and other causes. Provide temporary coverings or enclosures where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

END OF SECTION 07 21 00

SECTION 07 22 00
ROOF AND DECK INSULATION

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes rigid polyisocyanurate roof and deck insulation and GFR or CGF facer on the bottom for use with standing seam metal roof panels.

- 1. As indicated on plans

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00:

- 1. Refer to "PART 2 – PRODUCTS" for all Buy America Build America Act (BABA) Requirements.

- B. ROUGH CARPENTRY: Section 06 10 00.

- C. SELF-ADHERING SHEET UNDERLAYMENT: Section 07 13 20.

- D. STANDING SEAM METAL ROOF PANELS: Section 07 41 13.

1.03 SUBMITTALS

- A. Product Data: Manufacturer's specifications, installation instructions, and product data sheets for insulation board and related accessories.

- B. Shop Drawings: Roof plan showing layout of boards and fastening patterns.

- C. Samples: 6" x 6" of proposed board and related fasteners.

1.04 CODE/STANDARD COMPLIANCE

- A. Product Compliance: The roof and deck insulation shall have a State of Florida Product Control Notice of Acceptance (NOA) and meet all requirements of the Florida Product Approval System as required by Florida Statute 553.842 and Florida Administrative Code 9B-72.

- B. UL Class A Roof System requirements and FMG Class I Roof System for designated wind load per FMG Loss Prevention Data Sheet 1-28, "Wind Loads to Roof Systems and Roof Deck Securement."

- C. Comply with the following testing procedures:

- 1. Florida Building Code Test Protocol TAS 105-Test Procedure for Field Withdrawal Resistance Testing.

- 2. Florida Building Code Test Protocol TAS 114-Test Procedures for Roof System as the High Velocity Hurricane Zone Jurisdiction.

- a. Appendix A- Test Procedure for Above Deck Combustibility ASTM E 108.
- b. Appendix C-Test Procedure for Simulated Uplift Pressure Resistance of Roof System Assemblies.

1.05 1.05 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Company specializing in manufacturing products specified in this Section with minimum 10-years documented experience.
- B. Installer Qualifications: Company specializing in the installation of products specified in this Section with minimum 5-years documented experience using products of same type and scope as used for this Project.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products in packages labeled with material name, thermal value and product code.
- B. When stored outdoors or on the Project site, insulation shall be stacked on pallets at least 3-inches above ground level and completely covered with a waterproof covering. The temporary factory-applied packaging shall be slit or removed to prevent accumulation of condensation. Insulation which has become wet or damaged shall be removed and replaced with solid, dry insulation.

1.07 PROJECT CONDITIONS

- A. Sequencing: Coordinate with metal roofing installer and roof and deck insulation manufacturer's installation instructions.
- B. Maintain environmental conditions (temperature, humidity and ventilation) within limits recommended by roof and deck insulation manufacturer for optimum results. Do not install products under environmental conditions outside roof and deck insulation manufacturer's limits.

PART 2 - PRODUCTS

2.01 ROOF AND DECK INSULATION

- A. Basis of Design: HUNTER PANELS, H-SHIELD NB
- B. Roof and deck insulation shall be constructed as follows:
 - 1. Panel Area (Size): 4-foot x 8-foot.
 - 2. 3/4-inch thick CDX board.
 - 3. Polyisocyanurate Insulation, thickness as required to achieve R value - 25

4. GRF or CGF facer.
- C. Roof and deck insulation shall conform to the following:
1. ASTM C 1289, Type V.
 2. UL Standard 1256 Classification; Construction No. 120, 123 & 458.
 3. UL Standard 790 (ASTM E 108): For use with Class A, B or C Shingles, Metal or Tile Roof Coverings.
 4. FM Standard 4450 & 4470 Approved (1-90, 1-105); Approved for Class 1 Insulated Roof Deck Construction.
 5. State of Florida Product Approval: FL17989.
 6. Dimensional Stability: ASTM D 2126: <2%.
 7. Compressive Strength: ASTM D 1621: 25 psi.
 8. Water Absorption: ASTM C 209 (<1.5%).
 9. Water Vapor Transmission: ASTM E96: <1.0 perm.
 10. Product Density: ASTM D 1622: Nominal 2.0 pcf.
 11. Flame Spread: ASTM E 84 10 min.: 40-60.
 12. Smoke Developed: ASTM E 84 10 min.: 50-170.
 13. Tensile Strength: ASTM D 1623: 730 psf.
 14. Service Temperature: -100-degrees F to +250-degrees F.
- D. Nail Base Fasteners:
1. Manufacturer's engineered fastener for nailable insulation board in material, length, thickness, coating as recommended by manufacturer for applicable condition.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine precast concrete roof deck substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of Work.
1. Verify that substrate is sound, dry, smooth, clean and sloped for drainage.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Install roof and deck insulation in accordance with manufacturer's written instructions. Use approved mechanical fasteners as required by governing code requirements.
- B. Install with end joints staggered.

3.03 PROTECTION

- A. Remove trash and construction debris from insulation surface prior to application of roofing membrane.
- B. Do not leave installed insulation exposed to weather. Cover and waterproof completed roof system immediately after installation.
 - 1. Temporarily seal exposed insulation edges at the end of each work day.
 - 2. Remove and replace installed insulation that has become wet or damaged with new insulation.

END OF SECTION 07 22 00

SECTION 07 41 13
STANDING SEAM ROOF METAL PANELS

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Furnish and install standing seam metal roof panels and related attachments/accessories as indicated on Plans and specified herein.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00:
 - 1. Refer to "PART 2 – PRODUCTS" for all Buy America Build America Act (BABA) Requirements
- B. ROUGH CARPENTRY: Section 06 10 00.
- C. SELF-ADHERING SHEET UNDERLAYMENT: Section 07 13 20.
- D. ROOF AND DECK INSULATION: Section 07 22 00.
- E. FORMED METAL WALL PANELS: SECTION 07 42 13.13
- F. FLASHING AND SHEET METAL: Section 07 60 00.
- G. JOINT SEALANTS: Section 07 92 00.

1.03 PERFORMANCE REQUIREMENTS

- A. General: Provide metal roof panel assemblies that comply with performance requirements specified as determined by testing manufacturers' standard assemblies similar to those indicated for this Project, by a qualified testing and inspecting agency.
- B. Air Infiltration: Air leakage through assembly of not more than 0.06 cfm/sq. ft. of roof area when tested according to ASTM E 1680 at the following test-pressure difference:
 - 1. Test-Pressure Difference: Positive and negative 1.57 lbf/sq. ft.
 - 2. Positive Preload Test-Pressure Difference: Greater than or equal to 15.0 lbf/sq. ft. and the greater of 75 percent of building live load or 50 percent of building design positive wind-pressure difference.
 - 3. Negative Preload Test-Pressure Difference: 50 percent of design wind-uplift-pressure difference
- C. Water Penetration: No water penetration when tested according to ASTM E 1646 at the following test-pressure difference:
 - 1. Test-Pressure Difference; 20 percent of positive design wind pressure, but not less than 6.24 lbf/sq. ft. and not more than 120.0 lbf/sq. ft.

2. Positive Preload Test-Pressure Difference: Greater than or equal to 15.0 lbf/sq. ft. and the greater of 75 percent of building live load or 50 percent of building design positive wind-pressure difference.
 3. Negative Preload Test-Pressure Difference: 50 percent of design wind-uplift-pressure difference.
- D. Thermal Movements: Provide metal roof panel assemblies that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

1.04 CODE/STANDARD COMPLIANCE

- A. Product Compliance: The roofing system in its entirety will be provided as one of the following:
1. With a State of Florida Product Control Notice of Acceptance (NOA) and/or Florida Product Approval, and meet all requirements of the Florida Product Approval System as required by Florida Statute 553.842 and Florida Administrative Code 9B-72.
 2. Deferred engineering design for site-specific loading conditions and meeting or exceeding structural design requirements as specified herein and within the Plans.
- B. UL Class A Roof System requirements and FMG Class I Roof System for designated wind load per FMG Loss Prevention Data Sheet 1-28, "Wind Loads to Roof Systems and Roof Deck Securement."
- C. Provide roof covering materials bearing UL Classification Marking on bundle, package and/or container indicating that materials have been produced under UL's Classification and Follow-up Service.
- D. Comply with the following testing procedures:
1. Florida Building Code Test Protocol TAS 105-Test Procedure for Field Withdrawal Resistance Testing.
 2. Florida Building Code Test Protocol TAS 114-Test Procedures for Roof System as the High Velocity Hurricane Zone Jurisdiction.
 - a. Appendix A- Test Procedure for Above Deck Combustibility ASTM E 108.
 - b. Appendix C-Test Procedure for Simulated Uplift Pressure Resistance of Roof System Assemblies.

1.05 QUALITY ASSURANCE

- A. Installer Qualifications: An employer of workers trained and approved by manufacturer.
 - 1. Installer's responsibilities include fabricating and installing metal roof panel assemblies and providing professional engineering services needed to assume engineering responsibility.
 - 2. Engineering Responsibility: Preparation of data for metal roof panels and accessories, including shop drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.
- B. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated, as documented according to ASTM E 548.
- C. Source Limitations: Obtain each type of metal roof panels through one source from a single manufacturer.
- D. Pre-Installation Conference: Conduct conference at Project site. Review methods and procedures related to metal roof panel assemblies.
 - 1. Meet with Owner, Engineer, testing and inspecting agency representative, metal roof panel Installer, metal roof panel manufacturer's representative, deck Installer, and installers whose work interfaces with or affects metal roof panels including installers of roof accessories.

1.06 SUBMITTALS

- A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of metal roof panel and accessory.
- B. Shop Drawings: Show fabrication and installation layouts of metal roof panels; details of edge conditions, joints, panel profiles, corners, anchorages, trim, flashings, closures, and accessories; and special details. Distinguish between factory- and field-assembled work.
 - 1. Accessories: Include details of the following items, at a scale of not less than 1-1/2 inches per 12 inches:
 - a. Fascia, flashing and trim.
 - 2. For installed products indicated to comply with design loads, include structural analysis data signed and sealed by the qualified Professional Engineer currently registered in the State of Florida responsible for their preparation.
- C. Calculations Include calculations with registered engineer seal, verifying wall panel and attachment method resist wind pressures imposed on it pursuant to applicable building codes.
- D. Samples for Verification: For each type of exposed finish required, prepared on samples of size indicated below:

1. Metal Roof Panels: 12 inches long by actual panel width. Include fasteners, clips, closures, and other metal roof panel accessories.
 2. Fascia, Trim and Closures: 12 inches long. Include fasteners and other exposed accessories.
 3. Accessories: 12 inch long samples for each type of accessory.
- E. Qualification Data: For Installer and Manufacturer.
- F. Field quality control inspection reports.
- G. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for the following:
1. Metal Roof Panels: Include reports for air infiltration, water penetration, and structural performance.
- H. Maintenance Data: For metal roof panels to include in maintenance manuals.
- I. Warranties: Special warranties specified in this Section.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Deliver components, sheets, metal roof panels, and other manufactured items so as not to be damaged or deformed. Package metal roof panels for protection during transportation or handling.
- B. Unload, store, and erect metal roof panels in a manner to prevent bending, warping, twisting, and surface damage.
- C. Stack metal roof panels on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal roof panels to ensure dryness. Do not store metal roof panels in contact with other materials that might cause staining, denting, or other surface damage.
- D. Protect strippable protective covering on metal roof panels from exposure to sunlight and high humidity, except to extent necessary for period of metal roof panel installation.

1.08 PROJECT CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of metal roof panels to be performed according to manufacturers' written instruction and warranty requirements.
- B. Field Measurements: Verify locations of roof framing and roof opening dimensions by field measurements before metal roof panel fabrication and indicate measurements on shop drawings.

1.09 WARRANTY

- A. Manufacturer's Warranty: Manufacturer's standard form in which manufacturer agrees to

repair or replace components of metal roof panel assemblies that fail in materials or workmanship within specified warranty period.

1. Roofing panel manufacturer shall warranty against perforation or structural failure of metal roofing panels, underlayment, and associated accessories.
 2. Roofing panel manufacturer shall warranty the metal panel system will be watertight. Warranty will state if repairs are necessary, guarantor will provide materials and labor to make repairs at no cost to Owner.
 3. Warranty Period: 20 years from date of Final Acceptance
- B. Panel Finish Warranty: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal roof panels that show evidence of deterioration of factory-applied finishes within specified warranty period.
1. Roofing panel manufacturer shall warranty for minimum period of 5 years that the finish color will not change more than 5 NBS units in accordance with ASTM D 2244-78 and will not crack, peel or lose adhesion with the substrate for a period of 20 years.

PART 2 - PRODUCTS

2.01 PANEL MATERIALS

- A. Basis-of-Design:
1. Manufacturer: Berridge Manufacturing Company
 2. Product: Double-lock Zee-Lock Panel
 3. Metal Standing Seam Roof Panels and Wall Panels shall be the same manufacturer
- B. Metallic-Coated Steel Sheet Prepainted with Coil Coating: Steel sheet metallic coated by the hot-dip process and prepainted by the coil-coating process to comply with ASTM A 755.
1. Aluminum-Zinc Alloy-Coated Steel Sheet: Galvalume® ASTM A 792, AZ-50 coating designation, Grade 40; structural quality.
 2. Profile/Surface/Color: Roof panels to be selected as approved by /Engineer and/or Owner.
 3. Exposed Finishes: Apply the following coating, as specified or indicated on Plans:
 - a. High-Performance Organic Finish: AA-C12C42R1x. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 - (1) Fluoropolymer Two-Coat System: Manufacturer's standard two-coat, thermocured system consisting of specially formulated inhibitive primer and fluoropolymer color topcoat containing not

less than 70 percent polyvinylidene fluoride resin by weight; complying with AAMA 2605.

(2) Finish color shall be coordinated and approved by Architect.

4. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil.

C. Provide full length panels, typical with no intermediate lap joints.

2.02 UNDERLAYMENT MATERIALS

A. Refer to Section 07 13 20 – SELF-ADHERING SHEET UNDERLAYMENT and Section 07 22 00 – ROOF AND DECK INSULATION for substrate and underlayment materials.

1. Provide complete tested assembly with approved underlayment product and anchorages per manufacturer and deferred engineering design.

B. Slip Sheet (if required): Building paper, minimum 5 lb/100 sq. ft., rosin sized.

2.03 MISCELLANEOUS MATERIALS

A. Fasteners: Self-tapping screws, bolts, nuts, self-locking rivets and bolts, end-welded studs, and other suitable fasteners designed to withstand design loads. Provide exposed fasteners with heads matching color of metal roof panels by means of plastic caps or factory-applied coating.

1. Fasteners for Roof Panels: Self-drilling or self-tapping 410 stainless or zinc-alloy steel hex washer head, with EPDM or PVC washer under heads of fasteners bearing on weather side of metal roof panels.

2. Fasteners for Flashing and Trim: Blind fasteners or self-drilling screws with hex washer head.

3. Blind Fasteners: High-strength stainless steel rivets.

B. Bituminous Coating: Cold-applied asphalt mastic, SSPC-Paint 12, compounded for 15-mil dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

2.04 ACCESSORIES

A. Roof Panel Accessories: Provide components required for a complete metal roof panel assembly including trim, fascias, corner units, ridge closures, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal roof panels, unless otherwise indicated.

1. Closures: Provide closures at eaves and ridges, fabricated of same metal as metal roof panels.

2. Clips: Minimum 0.0625 inch thick, stainless steel panel clips designed to withstand

negative-load requirements.

3. Cleats: Mechanically seamed cleats formed from minimum 0.0250 inch thick, stainless steel.
 4. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
 5. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1 inch thick, flexible closure strips; cut or premolded to match metal roof panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.
- B. Flashing and Trim: Formed from 0.0179 inch thick, aluminum-zinc alloy-coated steel sheet pre-painted with coil coating. Provide flashing and trim as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, eaves, rakes, corners, bases, framed openings, ridges, fascias, and fillers. Finish flashing and trim with same finish system as adjacent metal roof panels.

2.05 FABRICATION

- A. General: Fabricate and finish metal roof panels and accessories at the factory to greatest extent possible, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.
- B. Provide panel profile for full length of panel.
- C. Sheet Metal Accessories: Fabricate flashing and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to the design, dimensions, metal, and other characteristics of item indicated.
1. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
 2. Sealed Joints: Form non-expansion but movable joints in metal to accommodate elastomeric sealant to comply with SMACNA standards.
 3. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.
 4. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended by metal roof panel manufacturer.
 - a. Size: As recommended by SMACNA's "Architectural Sheet Metal Manual" or metal roof panel manufacturer for application but not less than thickness of metal being secured.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances, metal roof panel supports, and other conditions affecting performance of work.
- B. Examine roughing-in for components and systems penetrating metal roof panels to verify actual locations of penetrations relative to seam locations of metal roof panels before metal roof panel installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 UNDERLAYMENT INSTALLATION

- A. Felt Underlayment (if required): Install felt underlayment and building-paper slip on membrane covered roof sheathing under metal roof panels, unless otherwise recommended by metal roof panel manufacturer. Use adhesive for temporary anchorage, where possible, to minimize use of mechanical fasteners under metal roof panels. Apply from eave to ridge, in shingle fashion to shed water, with lapped joints of not less than 2 inches.

3.03 METAL ROOF PANEL INSTALLATION, GENERAL

- A. General: Provide metal roof panels of full length from eave to ridge with no horizontal joints. Anchor metal roof panels and other components of the Work securely in place, with provisions for thermal and structural movement.
 - 1. Field cutting of metal roof panels by torch is not permitted.
 - 2. Rigidly fasten eave end of metal roof panels and allow ridge end free movement due to thermal expansion and contraction. Predrill panels.
 - 3. Provide metal closures at peaks, rake edges, and each side of ridge and hip caps.
 - 4. Flash and seal metal roof panels with weather closures at eaves, rakes, and at perimeter of all openings. Fasten with self-tapping screws.
 - 5. Locate and space fastenings in uniform vertical and horizontal alignment to provide equal temperature movement.
 - 6. Install ridge and hip caps as metal roof panel work proceeds.
 - 7. Locate panel splices over, but not attached to, structural supports. Stagger panel splices and end laps to avoid a four-panel lap splice condition.
 - 8. Lap metal flashing over metal roof panels to allow moisture to run over and off the material.
- B. Fasteners:
 - 1. Roof Panels: Use stainless steel fasteners for surfaces exposed to the exterior and

galvanized steel for surfaces exposed to the interior. Touch up exterior fasteners with panel color.

- C. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating, by applying rubberized-asphalt underlayment to each contact surface, or by other permanent separation as recommended by metal roof panel manufacturer.
 - 1. Coat back side of steel roof panels with bituminous coating where roof panels will contact wood, ferrous metal, or cementitious construction.
- D. Joint Sealers: Install gaskets, joint fillers, and sealants where indicated and where required for weatherproof performance of metal roof panel assemblies. Provide types of gaskets, fillers, sealants indicated or, if not otherwise indicated, types recommended by metal roof panel manufacturer.
 - 1. Seal side joints as recommended by metal roof panel manufacturer.
 - 2. Prepare joints and apply sealants to comply with requirements of Section 07 92 00 – JOINT SEALANT.

3.04 ACCESSORY INSTALLATION

- A. General: Install accessories with positive anchorage to building and weathertight mounting and provide for thermal expansion. Coordinate installation with flashings and other components.
 - 1. Install components required for a complete metal roof panel assembly including trim, copings, ridge closures, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items.
- B. Fascia, Flashing, Gutters, and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.
 - 1. Install exposed fascia, flashing and trim that is without excessive oil canning, buckling, and tool marks and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal fascia, flashing and trim to fit substrates and to result in waterproof and weather-resistant performance.
 - 2. Expansion Provisions: Provide for thermal expansion of exposed fascia, flashing and trim. Space movement joints at a maximum of 10 feet with no joints allowed within 24 inches of corner or intersection. Where lapped or bayonet-type expansion provisions cannot be used or would not be sufficiently weather resistant and waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with mastic sealant (concealed within joints).
- C. Touch up cut edges with manufacturer's matching color.

3.05 ERECTION TOLERANCES

- A. Installation Tolerances: Shim and align metal roof panel units within installed tolerance of 1/4 inch in 20 feet on slope and location lines as indicated and within 1/8 inch offset of adjoining faces and of alignment of matching profiles.

3.06 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect completed metal roof panel installation, including accessories. Report results in writing.
- B. Remove and replace applications of metal roof panels where inspections indicate that they do not comply with specified requirements.
- C. Additional inspections, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.07 CLEANING AND PROTECTION

- A. Remove temporary protective coverings and strippable films, if any, as metal roof panels are installed, unless otherwise indicated in manufacturer's written installation instructions. On completion of metal roof panel installation, clean finished surfaces as recommended by metal roof panel manufacturer. Maintain in a clean condition during construction.
- B. Replace metal roof panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 07 41 13

SECTION 07 42 13.13
FORMED METAL WALL PANELS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00:
 - 1. Refer to "PART 2 – PRODUCTS" for all Buy America Build America Act (BABA) Requirements
- B. ROUGH CARPENTRY: Section 06 10 00.
- C. SELF-ADHERING SHEET UNDERLAYMENT: Section 07 13 20.
- D. ROOF AND DECK INSULATION: Section 07 22 00.
- E. STANDING SEAM METAL ROOF PANELS: Section 07 41 13.
- F. FLASHING AND SHEET METAL: Section 07 60 00.
- G. JOINT SEALANTS: Section 07 92 00.

1.03 PERFORMANCE REQUIREMENTS

- A. General: Provide metal panel assemblies that comply with performance requirements specified as determined by testing manufacturers' standard assemblies similar to those indicated for this Project, by a qualified testing and inspecting agency.
- B. Air Infiltration: Air leakage through assembly of not more than 0.06 cfm/sq. ft. of area when tested according to ASTM E 1680 at the following test-pressure difference:
 - 1. Test-Pressure Difference: Positive and negative 1.57 lbf/sq. ft.
 - 2. Positive Preload Test-Pressure Difference: Greater than or equal to 15.0 lbf/sq. ft. and the greater of 75 percent of building live load or 50 percent of building design positive wind-pressure difference.
 - 3. Negative Preload Test-Pressure Difference: 50 percent of design wind-uplift-pressure difference
- C. Water Penetration: No water penetration when tested according to ASTM E 1646 at the following test-pressure difference:
 - 1. Test-Pressure Difference; 20 percent of positive design wind pressure, but not less than 6.24 lbf/sq. ft. and not more than 120.0 lbf/sq. ft.

2. Positive Preload Test-Pressure Difference: Greater than or equal to 15.0 lbf/sq. ft. and the greater of 75 percent of building live load or 50 percent of building design positive wind-pressure difference.
 3. Negative Preload Test-Pressure Difference: 50 percent of design wind-uplift-pressure difference.
- D. Thermal Movements: Provide metal panel assemblies that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

1.04 CODE/STANDARD COMPLIANCE

- A. Product Compliance: The system in its entirety will be provided as one of the following:
1. With a State of Florida Product Control Notice of Acceptance (NOA) and/or Florida Product Approval, and meet all requirements of the Florida Product Approval System as required by Florida Statute 553.842 and Florida Administrative Code 9B-72.
 2. Deferred engineering design for site-specific loading conditions and meeting or exceeding structural design requirements as specified herein and within the Plans.
- B. Comply with the following testing procedures:
1. Florida Building Code Test Protocol TAS 105-Test Procedure for Field Withdrawal Resistance Testing.
 2. Florida Building Code Test Protocol TAS 114-Test Procedures for System as the High Velocity Hurricane Zone Jurisdiction.

1.05 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.
- B. Manufacturer Qualifications: Company specializing in Architectural Sheet Metal Products.
- C. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated, as documented according to ASTM E 548.
- D. Source Limitations: Obtain each type of metal panels through one source from a single manufacturer.
- E. Pre-Installation Conference: Conduct conference at Project site. Review methods and procedures related to metal panel assemblies.

1. Meet with Owner, Engineer, testing and inspecting agency representative, metal panel Installer, metal panel manufacturer's representative, deck Installer, and installers whose work interfaces with or affects metal panels including installers of accessories.

1.06 SUBMITTALS

- A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of panel and accessory.
- B. Shop Drawings: Include fabrication and installation layouts of metal panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories; and special details.
 1. Accessories: Include details of the flashing, trim, and anchorage systems, at a scale of not less than 3" = 1'-0" (1:5).
- C. Calculations Include calculations with registered engineer seal, verifying wall panel and attachment method resist wind pressures imposed on it pursuant to applicable building codes.
- D. Samples for Verification: For each type of exposed finish, prepared on Samples of size indicated below:
 1. Metal Panels: 12 inches (305 mm) long by actual panel width. Include fasteners, closures, and other metal panel accessories.
- E. Qualification Data: For Installer and Manufacturer.
- F. Product Test Reports: For each product, for tests performed by a qualified testing agency.
- G. Field quality-control reports.
- H. Sample Warranties: For special warranties.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Deliver components, metal panels, and other manufactured items so as not to be damaged or deformed. Package metal panels for protection during transportation and handling.
- B. Unload, store, and erect metal panels in a manner to prevent bending, warping, twisting, and surface damage.
- C. Stack metal panels horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal panels to ensure dryness, with positive slope for drainage of water. Do not store metal panels in contact with other materials that might cause staining, denting, or other surface damage.
- D. Remove strippable protective covering on metal panels as panels are being installed. Do not leave the film on installed panels.

1.08 PROJECT CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of metal panels to be performed according to manufacturers' written instruction and warranty requirements.
- B. Field Measurements: Verify locations of framing and opening dimensions by field measurements before metal panel fabrication and indicate measurements on shop drawings.

1.09 COORDINATION

- A. Coordinate metal panel installation with rain drainage work, flashing, trim, construction of soffits, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.10 WARRANTY

- A. Galvalume Substrate Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal panel systems that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures including rupturing or perforating.
 - b. Deterioration of metals and other materials beyond normal weathering.
 - 2. Warranty Period: 20 years and 6 months from date of Substantial Completion.
- B. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal panels that show evidence of deterioration of factory-applied finishes within specified warranty period.
 - 1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
 - b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
 - c. Cracking, chipping, peeling, or failure of paint to adhere to bare metal.
 - 2. Finish Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 PANEL MATERIALS

- A. Basis-of-Design:

1. Manufacturer: Berridge Manufacturing Company
2. Product: HS-8 Metal Fascia and Soffit Wall Panel
3. Metal Standing Seam Roof Panels and Wall Panels shall be the same manufacturer

2.02 CONCEALED-FASTENER, LAP-SEAM METAL WALL PANELS

- A. General: Provide factory-formed metal panels designed to be field assembled by lapping and interconnecting side edges of adjacent panels and mechanically attaching through panel to supports using concealed fasteners in side laps. Include accessories required for weathertight installation.
- B. Wide-Reveal-Joint, Concealed-Fastener Metal Wall Panels
 1. Metallic-Coated Steel Sheet: Aluminum-zinc alloy-coated steel sheet complying with ASTM A 792/A 792M, Class AZ50 (Class AZM150) coating designation; structural quality. Prepainted by the coil-coating process to comply with ASTM A 755/A 755M.
 - a. Nominal Thickness: 0.029 inch (0.74 mm).
 - b. Surface: Smooth, flat finish.
 - c. Exterior Finish: Two-coat fluoropolymer
 - d. Color: As selected by Architect from manufacturer's full range.
 2. Panel Coverage: 8 inches (203 mm)
 3. Panel Height: 0.875 inches (22 mm).

2.03 UNDERLAYMENT MATERIALS

- A. Refer to Section 07 13 20 – SELF-ADHERING SHEET UNDERLAYMENT and Section 07 22 00 – ROOF AND DECK INSULATION for substrate and underlayment materials.
 1. Provide complete tested assembly with approved underlayment product and anchorages per manufacturer and deferred engineering design.
- B. Slip Sheet (if required): Building paper, minimum 5 lb/100 sq. ft., rosin sized.

2.04 MISCELLANEOUS MATERIALS

- A. Miscellaneous Metal Subframing and Furring: ASTM C 645, cold-formed, metallic-coated steel sheet, ASTM A 653/A 653M, G90 (Z275) hot-dip galvanized coating designation or ASTM A 792/A 792M, Class AZ50 (Class AZM150) aluminum-zinc-alloy coating designation unless otherwise indicated. Provide manufacturer's standard sections as required for support and alignment of metal panel system.
- B. Panel Accessories: Provide components required for a complete, weathertight panel system including trim, copings, fasciae, mullions, sills, corner units, clips, flashings, sealants,

gaskets, fillers, closure strips, and similar items. Match material and finish of metal panels unless otherwise indicated.

1. Closures: Provide closures at eaves and rakes, fabricated of same metal as metal panels.
 2. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
 3. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch- (25-mm-) thick, flexible closure strips; cut or premolded to match metal panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.
- C. Flashing and Trim: Provide flashing and trim formed from same material as metal panels as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, bases, drips, sills, jambs, corners, endwalls, framed openings, rakes, fasciae, parapet caps, soffits, reveals, and fillers. Finish flashing and trim with same finish system as adjacent metal panels.
- D. Panel Fasteners: Self-tapping screws designed to withstand design loads. Provide exposed fasteners with heads matching color of metal panels by means of factory-applied coating. Provide EPDM or PVC sealing washers for exposed fasteners.
- E. Panel Sealants: Provide sealant type recommended by manufacturer that are compatible with panel materials, are nonstaining, and do not damage panel finish.
1. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch (13 mm) wide and 1/8 inch (3 mm) thick.
 2. Joint Sealant: ASTM C 920; elastomeric polyurethane or silicone sealant; of type, grade, class, and use classifications required to seal joints in metal panels and remain weathertight; and as recommended in writing by metal panel manufacturer.
 3. Butyl-Rubber-Based, Solvent-Release Sealant: ASTM C 1311.

2.05 FABRICATION

- A. General: Fabricate and finish metal panels and accessories at the factory, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.
- B. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.
- C. Sheet Metal Flashing and Trim: Fabricate flashing and trim to comply with manufacturer's recommendations and recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item

indicated.

1. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
2. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.
3. Seams for Other Than Aluminum: Fabricate nonmoving seams in accessories with flat-lock seams. Tin edges to be seamed, form seams, and solder.
4. Sealed Joints: Form nonexpansion, but movable, joints in metal to accommodate sealant and to comply with SMACNA standards.
5. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.
6. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended in writing by metal panel manufacturer.
 - a. Size: As recommended by SMACNA's "Architectural Sheet Metal Manual" or metal wall panel manufacturer for application but not less than thickness of metal being secured.

2.06 FINISHES

- A. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- C. Steel Panels and Accessories:
 1. Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat applied by panel manufacturer on a continuous coil coating line, with a top side dry film thickness of 0.75 ± 0.05 mil (0.019 ± 0.0013 mm) over 0.2 ± 0.05 mil (0.05 ± 0.0013 mm) primer coat, to provide a total dry film thickness of 0.95 ± 0.10 mil (0.024 ± 0.0025 mm). Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 2. Mica Fluoropolymer: AAMA 621. Two-coat fluoropolymer finish with suspended mica flakes containing not less than 70 percent PVDF resin by weight in color coat applied by panel manufacturer on a continuous coil coating line, with a top side dry film thickness of 0.75 ± 0.05 mil (0.019 ± 0.0013 mm) over 0.2 ± 0.05 mil ($0.05 \pm$

0.0013 mm) primer coat, to provide a total dry film thickness of 0.95 ± 0.10 mil (0.024 ± 0.0025 mm). Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

3. Metallic Fluoropolymer: AAMA 621. Two-coat fluoropolymer finish with suspended metallic flakes containing not less than 70 percent PVDF resin by weight in color coat applied by panel manufacturer on a continuous coil coating line, with a top side dry film thickness of 0.75 ± 0.05 mil (0.019 ± 0.0013 mm) over 0.2 ± 0.05 mil (0.05 ± 0.0013 mm) primer coat, to provide a total dry film thickness of 0.95 ± 0.10 mil (0.024 ± 0.0025 mm). Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
4. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish consisting of prime coat and wash coat with a minimum total dry film thickness of 0.35 mil (0.009 mm). Metallic Fluoropolymer: AAMA 2605. Two-coat fluoropolymer finish with suspended metallic flakes containing not less than 70 percent PVDF resin by weight in color coat applied by panel manufacturer on a continuous coil coating line, with a top side dry film thickness of 0.75 ± 0.05 mil (0.019 ± 0.0013 mm) over 0.2 ± 0.05 mil (0.05 ± 0.0013 mm) primer coat, to provide a total dry film thickness of 0.95 ± 0.10 mil (0.024 ± 0.0025 mm). Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal panel supports, and other conditions affecting performance of the Work.
 1. Examine wall framing to verify that girts, angles, channels, studs, and other structural panel support members and anchorage have been installed within alignment tolerances required by metal wall panel manufacturer.
 2. Examine wall sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances required by metal wall panel manufacturer.
 - a. Verify that air- or water-resistive barriers have been installed over sheathing or backing substrate to prevent air infiltration or water penetration.
- B. Examine roughing-in for components and systems penetrating metal panels to verify actual locations of penetrations relative to seam locations of metal panels before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Miscellaneous Supports: Install subframing, furring, and other miscellaneous panel support members and anchorages according to ASTM C 754 and metal panel manufacturer's written recommendations.

3.03 METAL PANEL INSTALLATION

- A. General: Install metal panels according to manufacturer's written instructions in orientation, sizes, and locations indicated. Install panels perpendicular to supports unless otherwise indicated. Anchor metal panels and other components of the Work securely in place, with provisions for thermal and structural movement.
 - 1. Shim or otherwise plumb substrates receiving metal panels.
 - 2. Flash and seal metal panels at perimeter of all openings. Fasten with self-tapping screws. Do not begin installation until air- or water-resistive barriers and flashings that will be concealed by metal panels are installed.
 - 3. Install screw fasteners in predrilled holes.
 - 4. Locate and space fastenings in uniform vertical and horizontal alignment.
 - 5. Install flashing and trim as metal panel work proceeds.
 - 6. Locate panel splices over, but not attached to, structural supports. Stagger panel splices and end laps to avoid a four-panel lap splice condition.
 - 7. Align bottoms of metal panels and fasten with blind rivets, bolts, or self-tapping screws. Fasten flashings and trim around openings and similar elements with self-tapping screws.
 - 8. Provide weathertight escutcheons for pipe- and conduit-penetrating panels.
- B. Fasteners:
 - 1. Steel Panels: Use stainless-steel fasteners for surfaces exposed to the exterior; use galvanized-steel fasteners for surfaces exposed to the interior.
 - 2. Aluminum Panels: Use stainless-steel fasteners for surfaces exposed to the exterior; use stainless-steel fasteners for surfaces exposed to the interior.
- C. Metal Protection: Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action as recommended in writing by metal panel manufacturer.
- D. Lap-Seam Metal Panels: Fasten metal panels to supports with fasteners at each lapped joint at location and spacing recommended by manufacturer.
 - 1. Lap ribbed or fluted sheets one full rib. Apply panels and associated items true to line for neat and weathertight enclosure.
 - 2. Provide metal-backed washers under heads of exposed fasteners bearing on

weather side of metal panels.

3. Locate and space exposed fasteners in uniform vertical and horizontal alignment. Use proper tools to obtain controlled uniform compression for positive seal without rupture of washer.
4. Install screw fasteners with power tools having controlled torque adjusted to compress washer tightly without damage to washer, screw threads, or panels. Install screws in predrilled holes.
5. Flash and seal panels with weather closures at perimeter of all openings.

E. Watertight Installation:

1. Apply a continuous ribbon of sealant or tape to seal lapped joints of metal panels, using sealant or tape as recommend by manufacturer on side laps of nesting-type panels; and elsewhere as needed to make panels watertight.
2. Provide sealant or tape between panels and protruding equipment, vents, and accessories.
3. At panel splices, nest panels with minimum 6-inch (152-mm) end lap, sealed with sealant and fastened together by interlocking clamping plates.

F. Accessory Installation: Install accessories with positive anchorage to building and weathertight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.

1. Install components required for a complete metal panel system including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items. Provide types indicated by metal wall panel manufacturer; or, if not indicated, provide types recommended by metal panel manufacturer.

G. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that are permanently watertight.

1. Install exposed flashing and trim that is without buckling and tool marks, and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and achieve waterproof performance.
2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet (3 m) with no joints allowed within 24 inches (610 mm) of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with mastic sealant (concealed within joints).

3.04 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Water-Spray Test: After installation, test area of assembly for water penetration according to AAMA 501.2.
- C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect completed metal wall panel installation, including accessories.
- D. Remove and replace metal wall panels where tests and inspections indicate that they do not comply with specified requirements.
- E. Additional tests and inspections, at Contractor's expense, are performed to determine compliance of replaced or additional work with specified requirements.
- F. Prepare test and inspection reports.

3.05 CLEANING AND PROTECTION

- A. Remove temporary protective coverings and strippable films, if any, as metal panels are installed, unless otherwise indicated in manufacturer's written installation instructions. On completion of metal panel installation, clean finished surfaces as recommended by metal panel manufacturer. Maintain in a clean condition during construction.
- B. After metal panel installation, clear weep holes and drainage channels of obstructions, dirt, and sealant.
- C. Replace metal panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 07 42 13.13

SECTION 07 62 00
SHEET METAL FLASHING AND TRIM

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes:
 - 1. Sheet metal flashings, rain gutters and downspouts, and all miscellaneous sheet metal work required for roofing and related work, complete as indicated on Plans and by provision of this Section.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00:
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) Requirements
- B. ROUGH CARPENTRY: Section 06 10 00.
- C. SELF-ADHERING SHEET UNDERLAYMENT: Section 07 13 20.
- D. ROOF AND DECK INSULATION: Section 07 22 00.
- E. STANDING SEAM METAL ROOF PANELS: Section 07 41 13.
- F. FORMED METAL WALL PANELS: SECTION 07 42 13.13.
- G. JOINT SEALANTS: Section 07 92 00.

1.03 QUALITY ASSURANCE

- A. Installer's Qualifications: Flashing and sheet metal work shall be fabricated by a qualified sheet metal fabricator with at least five (5) years documented experience in installations of a similar nature.
- B. Reference Standards: Comply with provisions of the following, unless otherwise indicated or specified:
 - 1. American Architectural Manufacturers Association (AAMA):
 - a. Referenced Standards.
 - 2. American Society for Testing and Materials (ASTM):
 - a. Referenced Standards.
 - 3. Factory Mutual Global (FMG):
 - a. Referenced Standards.

4. Federal Specifications (FS):
 - a. Referenced Standards.
 5. Sheet Metal and Air Conditioning Contractors National Association (SMACNA):
 - a. Referenced Standards.
- C. Performance Requirements:
1. Wind Uplift Resistance: Installation of all sheet metal work and soffit system shall comply with FMG 1-90 wind uplift requirements in FMG Loss Prevention Data Sheet 1-28, "Wind Loads to Roof Systems and Roof Deck Securement."
 2. The assemblies shall conform to the Florida Building Code requirements for Certification of Exterior Products and Materials (Notice of Approval).

1.04 SUBMITTALS

- A. Product Data: Submit complete product data, including manufacturer's material and finish data, installation instructions, and general recommendations for each specified flashing material and fabricated product.
- B. Shop Drawings: Complete shop drawings shall be prepared for all flashing and sheet metal work fabrication, soffit system, assembly, and attachment details, size of all members, fastening devices, supports and anchors, patterns, clearances, and all necessary connections to work of other trades.
- C. Installer's Qualifications: Submit documented evidence of installer's qualifications.
- D. Warranty: Submit specimen copy of specified warranty.

1.05 HANDLING AND STORAGE

- A. Sheet metal materials shall be carefully handled to prevent damage to surfaces, edges, and ends; and shall be stored at the site above the ground in a covered, dry location. Damaged items that cannot be restored to original condition will be rejected and shall be replaced at no additional cost to the Owner.

1.06 PROJECT CONDITIONS

- A. Coordinate work of this Section with interfacing and adjoining work for proper sequencing of each installation. Ensure best possible weather resistance and durability of work and protection of materials and finishes.

1.07 WARRANTY

- A. Finish Warranty: Provide manufacturer's standard fifteen (15) year written performance warranty.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Pre-Finished Galvanized (Hot-Dipped) Sheet Metal Material:

1. Pre-finished galvanized (hot-dipped) sheet metal coping, rain gutters and downspouts, and all miscellaneous sheet metal items indicated on Drawings shall be fabricated to shapes detailed on Plans.
2. Galvanized steel sheet shall comply with ASTM A 653, G 90, commercial quality, for hot-dip galvanized steel sheet, mill phosphatized where indicated for painting. Provide minimum 24 gauge material thickness, unless otherwise indicated on Plans.
3. Pre-Finish:
 - a. Provide manufacturer's standard fluoropolymer 2-coat thermocured coating system composed of specially formulated inhibitive primer and fluoropolymer color topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight; complying with AAMA 2605.
 - (1) Color to be selected by Engineer or Owner.
 - b. Products, Resin Manufacturers: Provide fluoropolymer coating systems containing one of the following resins:
 - (1) "Hylar 5000"; Ausimont USA, Inc.
 - (2) "Kynar 500"; Atofina Chemicals, Inc.

2.02 FABRICATION

- A. Shop fabricate work to greatest extent possible, with applicable requirements of SMACNA "Architectural Sheet Metal Manual" and other recognized industry practices. Fabricate for waterproof and weather-resistant performance; with expansion provisions for running work, sufficient to permanently prevent leakage, damage or deterioration of the work.
- B. Form work to fit substrates. Comply with material manufacturer's published instructions and current recommendations for forming material. Form exposed sheet metal work without excessive oil-canning, buckling and tool marks, true to line and levels indicated, with exposed edges folded back to form hems.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Surfaces that are to receive sheet metal work shall be even, smooth, sound, thoroughly clean and dry, and free from defects that might affect their application.

3.02 INSTALLATION

- A. Install sheet metal fabrications as required for the work.

- B. Perform cutting, fitting, drilling, and other operations as required to complete the work. Accessories and other components necessary to complete the work, whether or not specifically indicated or specified, shall be provided. Where sheet metal abuts or extends into adjacent materials, the juncture shall be executed in a manner to ensure weathertight construction.
- C. Manufactured items shall be installed in strict accordance with manufacturer's published instructions.
- D. All surfaces exposed to view shall be installed using continuous cleats to provide no visible fasteners.

3.03 CLEAN UP

- A. Clean exposed metal surfaces, removing substances that might cause corrosion of metal or deterioration of finishes.

END OF SECTION 07 62 00

SECTION 07 84 13
PENETRATION FIRESTOPPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. SUMMARY OF WORK: Section 01 11 00:
 - 1. Refer to "PART 2 – PRODUCTS" for all Buy America Build America Act (BABA) Requirements
- B. Division 07 Section "Fire-Resistive Joint Systems" for joints in or between fire-resistance-rated construction, at exterior curtain-wall/floor intersections, and in smoke barriers.

1.02 SUMMARY

- A. Section Includes:
 - 1. Penetrations in fire-resistance-rated walls.
 - 2. Penetrations in horizontal assemblies.
 - 3. Penetrations in smoke barriers.
- B. Related Sections:
 - 1. Division 07 Section "Fire-Resistive Joint Systems" for joints in or between fire-resistance-rated construction, at exterior curtain-wall/floor intersections, and in smoke barriers.

1.03 SUBMITTALS

- A. Product Data: For each type of product indicated.
 - 1. Include printed statement of VOC content and chemical components.
- B. Product Schedule: For each penetration firestopping system. Include location and design designation of qualified testing and inspecting agency.
 - 1. Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular penetration firestopping condition, submit illustration, with modifications marked, approved by penetration firestopping manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly.
- C. Qualification Data: For qualified Installer.
- D. Installer Certificates: From Installer indicating penetration firestopping has been installed in compliance with requirements and manufacturer's written recommendations.
- E. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified

testing agency, for penetration firestopping.

1.04 QUALITY ASSURANCE

- A. Installer Qualifications: A firm that has been approved by FM Global according to FM Global 4991, "Approval of Firestop Contractors," or been evaluated by UL and found to comply with its "Qualified Firestop Contractor Program Requirements."
- B. Fire-Test-Response Characteristics: Penetration firestopping shall comply with the following requirements:
 - 1. Penetration firestopping tests are performed by a qualified testing agency acceptable to authorities having jurisdiction.
 - 2. Penetration firestopping is identical to those tested per testing standard referenced in "Penetration Firestopping" Article. Provide rated systems complying with the following requirements:
 - a. Penetration firestopping products bear classification marking of qualified testing and inspecting agency.
 - b. Classification markings on penetration firestopping correspond to designations listed by the following:
 - (1) UL in its "Fire Resistance Directory."

1.05 PROJECT CONDITIONS

- A. Environmental Limitations: Do not install penetration firestopping when ambient or substrate temperatures are outside limits permitted by penetration firestopping manufacturers or when substrates are wet because of rain, condensation, or other causes.
- B. Install and cure penetration firestopping per manufacturer's written instructions using natural means of ventilations or, where this is inadequate, forced-air circulation.

1.06 COORDINATION

- A. Coordinate construction of openings and penetrating items to ensure that penetration firestopping is installed according to specified requirements.
- B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate penetration firestopping.

PART 2 - PRODUCTS

2.01 PENETRATION FIRESTOPPING

- A. Provide penetration firestopping that is produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated. Penetration firestopping systems shall be compatible with one another, with the substrates forming openings, and with penetrating items if any.

- B. Penetrations in Fire-Resistance-Rated Walls: Provide penetration firestopping with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg.
1. Fire-resistance-rated walls include fire walls, fire-barrier walls, smoke-barrier walls.
 2. F-Rating: Not less than the fire-resistance rating of constructions penetrated.
- C. Penetrations in Horizontal Assemblies: Provide penetration firestopping with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg.
1. Horizontal assemblies include floors, floor/ceiling assemblies, and ceiling membranes of roof/ceiling assemblies.
 2. F-Rating: At least 2 hour, but not less than the fire-resistance rating of constructions penetrated.
 3. T-Rating: At least 2 hour, but not less than the fire-resistance rating of constructions penetrated except for floor penetrations within the cavity of a wall.
- D. Penetrations in Smoke Barriers: Provide penetration firestopping with ratings determined per UL 1479.
1. L-Rating: Not exceeding 5.0 cfm/sq. ft. of penetration opening at 0.30-inch wg at both ambient and elevated temperatures.
 2. W-Rating: Provide penetration firestopping showing no evidence of water leakage when tested according to UL 1479.
- E. Exposed Penetration Firestopping: Provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.
- F. VOC Content: Provide penetration firestopping that complies with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
1. Architectural Sealants: 250 g/L.
 2. Sealant Primers for Nonporous Substrates: 250 g/L.
 3. Sealant Primers for Porous Substrates: 775 g/L.
- G. Accessories: Provide components for each penetration firestopping system that are needed to install fill materials and to maintain ratings required. Use only those components specified by penetration firestopping manufacturer and approved by qualified testing and inspecting agency for firestopping indicated.
1. Permanent forming/damming/backing materials, including the following:
 - a. Slag-wool-fiber or rock-wool-fiber insulation.

- b. Sealants used in combination with other forming/damming/backing materials to prevent leakage of fill materials in liquid state.
 - c. Fire-rated form board.
 - d. Fillers for sealants.
2. Temporary forming materials.
 3. Substrate primers.
 4. Collars.
 5. Steel sleeves.

2.02 FILL MATERIALS

- A. Cast-in-Place Firestop Devices: Factory-assembled devices for use in cast-in-place concrete floors and consisting of an outer metallic sleeve lined with an intumescent strip, a radial extended flange attached to one end of the sleeve for fastening to concrete formwork, and a neoprene gasket.
- B. Latex Sealants: Single-component latex formulations that do not re-emulsify after cure during exposure to moisture.
- C. Firestop Devices: Factory-assembled collars formed from galvanized steel and lined with intumescent material sized to fit specific diameter of penetrant.
- D. Intumescent Composite Sheets: Rigid panels consisting of aluminum-foil-faced elastomeric sheet bonded to galvanized-steel sheet.
- E. Intumescent Putties: Nonhardening dielectric, water-resistant putties containing no solvents, inorganic fibers, or silicone compounds.
- F. Intumescent Wrap Strips: Single-component intumescent elastomeric sheets with aluminum foil on one side.
- G. Mortars: Prepackaged dry mixes consisting of a blend of inorganic binders, hydraulic cement, fillers, and lightweight aggregate formulated for mixing with water at Project site to form a nonshrinking, homogeneous mortar.
- H. Pillows/Bags: Reusable heat-expanding pillows/bags consisting of glass-fiber cloth cases filled with a combination of mineral-fiber, water-insoluble expansion agents, and fire-retardant additives. Where exposed, cover openings with steel-reinforcing wire mesh to protect pillows/bags from being easily removed.
- I. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.
- J. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below:

1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces, and nonsag formulation for openings in vertical and sloped surfaces, unless indicated firestopping limits use of nonsag grade for both opening conditions.

2.03 MIXING

- A. For those products requiring mixing before application, comply with penetration firestopping manufacturer's written instructions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for application indicated.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Surface Cleaning: Clean out openings immediately before installing penetration firestopping to comply with manufacturer's written instructions and with the following requirements:
 1. Remove from surfaces of opening substrates and from penetrating items foreign materials that could interfere with adhesion of penetration firestopping.
 2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with penetration firestopping. Remove loose particles remaining from cleaning operation.
 3. Remove laitance and form-release agents from concrete.
- B. Priming: Prime substrates where recommended in writing by manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.
- C. Masking Tape: Use masking tape to prevent penetration firestopping from contacting adjoining surfaces that will remain exposed on completion of the Work and that would otherwise be permanently stained or damaged by such contact or by cleaning methods used to remove stains. Remove tape as soon as possible without disturbing firestopping's seal with substrates.

3.03 INSTALLATION

- A. General: Install penetration firestopping to comply with manufacturer's written installation

instructions, UL and published drawings for products and applications indicated.

- B. Install forming materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.
- C. Install fill materials for firestopping by proven techniques to produce the following results:
 - 1. Fill voids and cavities formed by openings, forming materials, accessories, and penetrating items as required to achieve fire-resistance ratings indicated.
 - 2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
 - 3. For fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.04 IDENTIFICATION

- A. Identify penetration firestopping with preprinted metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches of firestopping edge so labels will be visible to anyone seeking to remove penetrating items or firestopping. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:
 - 1. The words "Warning - Penetration Firestopping - Do Not Disturb. Notify Building Management of Any Damage."
 - 2. Contractor's name, address, and phone number.
 - 3. Designation of applicable testing and inspecting agency.
 - 4. Date of installation.
 - 5. Manufacturer's name.
 - 6. Installer's name.

3.05 FIELD QUALITY CONTROL

- A. Engage a qualified testing agency to perform tests and inspections.
- B. Where deficiencies are found or penetration firestopping is damaged or removed because of testing, repair or replace penetration firestopping to comply with requirements.
- C. Proceed with enclosing penetration firestopping with other construction only after inspection reports are issued and installations comply with requirements.

3.06 CLEANING AND PROTECTION

- A. Clean off excess fill materials adjacent to openings as the Work progresses by methods and with cleaning materials that are approved in writing by penetration firestopping

manufacturers and that do not damage materials in which openings occur.

- B. Provide final protection and maintain conditions during and after installation that ensure that penetration firestopping is without damage or deterioration at time of Substantial Completion.

3.07 PENETRATION FIRESTOPPING SCHEDULE

- A. As indicated on drawings.

END OF SECTION 07 84 13

SECTION 07 84 46
FIRE-RESISTIVE JOINT SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. SUMMARY OF WORK: Section 01 11 00:
 - 1. Refer to "PART 2 – PRODUCTS" for all Buy America Build America Act (BABA) Requirements
- B. Division 07 Section "Fire-Resistive Joint Systems" for joints in or between fire-resistance-rated construction, at exterior curtain-wall/floor intersections, and in smoke barriers.

1.02 SUMMARY

- A. Section Includes:
 - 1. Joints in or between fire-resistance-rated constructions.
 - 2. Joints in smoke barriers.

1.03 SUBMITTALS

- A. Product Data: For each type of product indicated.
 - 1. For fire-resistive joint systems, including printed statement of VOC content.
- B. Product Schedule: For each fire-resistive joint system. Include location and design designation of qualified testing agency.
 - 1. Where Project conditions require modification to a qualified testing agency's illustration for a particular fire-resistive joint system condition, submit illustration, with modifications marked, approved by fire-resistive joint system manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly.
- C. Qualification Data: For qualified Installer.
- D. Installer Certificates: From Installer indicating fire-resistive joint systems have been installed in compliance with requirements and manufacturer's written recommendations.
- E. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for fire-resistive joint systems.

1.04 QUALITY ASSURANCE

- A. Installer Qualifications: A firm that has been approved by FM Global according to FM Global 4991, "Approval of Firestop Contractors," or been evaluated by UL and found to comply with UL's "Qualified Firestop Contractor Program Requirements."

- B. Fire-Test-Response Characteristics: Fire-resistive joint systems shall comply with the following requirements:
 - 1. Fire-resistive joint system tests are performed by a qualified testing agency acceptable to authorities having jurisdiction.
 - 2. Fire-resistive joint systems are identical to those tested per testing standard referenced in "Fire-Resistive Joint Systems" Article. Provide rated systems complying with the following requirements:
- C. Fire-resistive joint system products bear classification marking of qualified testing agency.
- D. Fire-resistive joint systems correspond to those indicated by reference to designations listed by the following:
 - 1. UL in its "Fire Resistance Directory."

1.05 PROJECT CONDITIONS

- A. Environmental Limitations: Do not install fire-resistive joint systems when ambient or substrate temperatures are outside limits permitted by fire-resistive joint system manufacturers or when substrates are wet due to rain, frost, condensation, or other causes.
- B. Install and cure fire-resistive joint systems per manufacturer's written instructions using natural means of ventilation or, where this is inadequate, forced-air circulation.

1.06 COORDINATION

- A. Coordinate construction of joints to ensure that fire-resistive joint systems are installed according to specified requirements.
- B. Coordinate sizing of joints to accommodate fire-resistive joint systems.

PART 2 - PRODUCTS

2.01 FIRE-RESISTIVE JOINT SYSTEMS

- A. Where required, provide fire-resistive joint systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of assemblies in or between which fire-resistive joint systems are installed. Fire-resistive joint systems shall accommodate building movements without impairing their ability to resist the passage of fire and hot gases.
- B. Joints in or between Fire-Resistance-Rated Construction: Provide fire-resistive joint systems with ratings determined per ASTM E 1966 or UL 2079:
 - 1. Joints include those installed in or between fire-resistance-rated walls, floor or floor/ceiling assemblies and roofs or roof/ceiling assemblies.
 - 2. Fire-Resistance Rating: Equal to or exceeding the fire-resistance rating of construction they will join.

- C. Joints at Exterior Curtain-Wall/Floor Intersections: Provide fire-resistive joint systems with rating determined by ASTM E 119 based on testing at a positive pressure differential of 0.01-inch wg or ASTM E 2307.
 - 1. Fire-Resistance Rating: Equal to or exceeding the fire-resistance rating of the floor assembly.
- D. Joints in Smoke Barriers: Provide fire-resistive joint systems with ratings determined per UL 2079.
 - 1. L-Rating: Not exceeding 5.0 cfm/ft of joint at 0.30 inch wg at both ambient and elevated temperatures.
- E. Exposed Fire-Resistive Joint Systems: Provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.
- F. VOC Content: Provide fire-resistive joint systems that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
 - 1. Architectural Sealants: 250 g/L.
 - 2. Sealant Primers for Nonporous Substrates: 250 g/L.
 - 3. Sealant Primers for Porous Substrates: 775 g/L.
- G. Accessories: Provide components of fire-resistive joint systems, including primers and forming materials, that are needed to install fill materials and to maintain ratings required. Use only components specified by fire-resistive joint system manufacturer and approved by the qualified testing agency for systems indicated.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Priming: Prime substrates where recommended in writing by fire-resistive joint system manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.
- B. Install fire-resistive joint systems to comply with manufacturer's written installation instructions and published drawings for products and applications indicated.
- C. Install forming materials and other accessories of types required to support fill materials during their application and in position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.
 - 1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of fire-resistive joint system.
- D. Install fill materials for fire-resistive joint systems by proven techniques to produce the following results:

1. Fill voids and cavities formed by joints and forming materials as required to achieve fire-resistance ratings indicated.
2. Apply fill materials so they contact and adhere to substrates formed by joints.
3. For fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.02 IDENTIFICATION

- A. Identify fire-resistive joint systems with preprinted metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches of joint edge so labels will be visible to anyone seeking to remove or penetrate joint system. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:
 1. The words "Warning - Fire-Resistive Joint System - Do Not Disturb. Notify Building Management of Any Damage."
 2. Contractor's name, address, and phone number.
 3. Designation of applicable testing agency.
 4. Date of installation.
 5. Manufacturer's name.
 6. Installer's name.

3.03 FIELD QUALITY CONTROL

- A. Inspecting Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Where deficiencies are found or fire-resistive joint systems are damaged or removed due to testing, repair or replace fire-resistive joint systems so they comply with requirements.
- C. Proceed with enclosing fire-resistive joint systems with other construction only after inspection reports are issued and installations comply with requirements.
- D. Clean off excess fill materials adjacent to joints as the Work progresses by methods and with cleaning materials that are approved in writing by fire-resistive joint system manufacturers and that do not damage materials in which joints occur.
- E. Provide final protection and maintain conditions during and after installation that ensure fire-resistive joint systems are without damage or deterioration at time of Substantial Completion.

END OF SECTION 07 84 46

SECTION 07 92 00
JOINT SEALANTS

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes:
 - 1. Joint sealants and caulking as indicated on the Plans and as specified herein.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00:
 - 1. Refer to "PART 2 – PRODUCTS" for all Buy America Build America Act (BABA) Requirements
- B. HOLLOW METAL DOORS AND FRAMES: Section 08 11 13.
- C. ALUMINUM-FRAMED ENTRANCES AND STOREFRONTS: Section 08 41 13.
- D. GLASS AND GLAZING: Section 08 81 00
- E. FIXED LOUVERS: Section 08 91 19.
- F. PAINTING: Section 09 91 00.

1.03 QUALITY ASSURANCE

- A. Installer Qualifications: The Installer shall have a minimum of five (5) years continuous documented experience in the application of the types of materials required, and approved or licensed by the manufacturer to install elastomeric sealants required for this Project.
- B. Product Testing: Obtain test results for test reports required as submittals from a qualified testing agency based on testing current sealant formulations within a 36 month period preceding commencement of the Work.
 - 1. Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated, as documented according to ASTM E 548.
 - 2. Test elastomeric joint sealants for compliance with requirements specified by reference to ASTM C 920, and where applicable, to other standard test methods.
 - 3. Test other joint sealants for compliance with requirements indicated by referencing standard specification and test methods.
- C. Performance Requirements: Provide elastomeric joint sealants that establish and maintain watertight and airtight continuous joint seals without staining or deteriorating joint substrates.

1.04 SUBMITTALS

- A. Product Data: Submit complete manufacturer's technical data for each manufactured item. Include the following:
 - 1. Certification that each product to be furnished is recommended for the application shown.
 - 2. Complete instructions for handling, storage, mixing, priming, installation, curing, and protection of each type of sealant.
- B. Samples: Submit the following samples:
 - 1. One tube, in original sealed container, of each sealant specified.
 - 2. 12 inch length of each joint filler specified.
- C. Qualification Data: For Installer and testing agency.
- D. Compatibility and Adhesion Test Reports: From sealant manufacturer, indicating the following:
 - 1. Materials forming joint substrates and joint sealant backings have been tested for compatibility and adhesion with joint sealants.
 - 2. Interpretation of test results and written recommendations for primers and substrate preparation needed for adhesion.

1.05 PRODUCT DELIVERY AND STORAGE

- A. Deliver all products to the Project site undamaged, and in the manufacturer's original packing. Store products within the manufacturers' published temperature tolerances.

1.06 ENVIRONMENTAL CONDITIONS

- A. Do not install joint sealant materials when the ambient and substrate temperatures are below 40 degrees F, unless the manufacturer specifically recommends application of materials at lower temperatures. If Project progress or any other condition requires installations when ambient and substrate temperatures are below 40 degrees F (or below the minimum installation temperature recommended by the manufacturer), consult the manufacturer's representative and establish the minimum provisions required to ensure satisfactory work. Record in writing to the manufacturer, with a copy to the Engineer, the conditions under which such installation must proceed, and the provisions made to ensure satisfactory work.
- B. Do not proceed with installation of bulk compounds during inclement weather unless the full compliance with all requirements and manufacturer's published instructions.
- C. Do not proceed with the installation of elastomeric sealants under extreme temperature conditions which would cause joint openings to be at either maximum or minimum width, or when such extreme temperatures or heavy wind loads are forecast during the period required for initial or nominal cure of elastomeric sealants. Whenever possible, schedule

the installation and cure of elastomeric sealants during periods of mean temperatures (nominal joint width shown) so that subsequent stresses upon the cured sealants will be minimized.

1.07 WARRANTY

A. Special Project Warranty: Provide a written warranty, signed by the installer and Contractor, against defects materials and workmanship for joint sealants which fail to perform as airtight or watertight joints; or fail in joint adhesion, cohesion, abrasion resistance, weather resistance, extrusion resistance, migration resistance, stain resistance, or general durability; or appear to deteriorate in any other manner not clearly specified in joint sealant manufacturer's published data as an inherent quality of the material for the exposure indicated.

1. Warranty Period: Five (5) years from the date of Final Acceptance.

PART 2 - PRODUCTS

2.01 GENERAL

A. Hardnesses indicated and specified are intended to indicate the general range necessary for overall performance. The manufacturer's technical representative shall determine the actual hardness recommended for the conditions of installation and use. Except as otherwise indicated or recommended, compounds shall be provided within the range of hardness (Shore A, Fully cured, at 75 degrees F) of 25 to 40.

B. Prior to installation of each specified sealant, confirm its compatibility with the joint surfaces, joint fillers, and other materials in the joint system. Only materials that are known to be fully compatible with the actual installation conditions, as shown by manufacturer's published data or certification, shall be provided.

2.02 SEALANTS

A. Exterior Sealants: Sealants for exterior locations and all interior and exterior expansion joints shall be cold-applied elastomeric joint sealant, two-part polyurethane sealant complying with ASTM C 920.

1. Products, Horizontal Joints: Provide one of the following Type M (multicomponent), Class 25, Use T (traffic) sealants:

- a. "Urexpam NR-200"; Pecora Corporation.
- b. "Vulkem 245"; Tremco.
- c. "Sonolastic SL 2"; Sonneborn, Div. of ChemRex Inc.

2. Products, Vertical Joints: Provide one of the following Type M (multicomponent), Class 25, Use NT (nontraffic) sealants:

- a. "Dynatrol II"; Pecora Corporation.
- b. "Vulkem 227"; Tremco.

- c. "Sonolastic NP 2"; Sonneborn, Div. of ChemRex Inc.
- B. Interior Sealants: Sealants for interior locations shall be acrylic latex sealant compound, non-staining, non-bleeding, paintable, complying with ASTM C 834.
 - 1. Products: Provide one of the following sealants:
 - a. "AC-20+"; Pecora Corporation.
 - b. "Sanilac"; Sonneborn, Div. of ChemRex Inc.
 - c. "Tremflex 834"; Tremco.

2.03 MISCELLANEOUS MATERIALS

- A. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.
- B. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by the sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint filler materials or joint surfaces at back of joint where such adhesion would result in sealant failure. Provide self-adhesive tape where applicable.
- C. Backer Rods: Provide closed-cell, expanded polyethylene backer rods. The size and shape of the rod shall be that which will control the joint, form optimum shape of sealant bead on the back side, and provide a highly compressible backer to minimize the possibility of sealant extrusion when the joint is compressed.
 - 1. Basis of Design: "Ethafoam"; Dow Chemical Company.

2.04 COLORS

- A. For concealed joints, provide manufacturer's standard color from the product that has the best overall performance qualities for the application shown. For exposed joints, the Architect or Owner will select colors from the manufacturer's standard or premium line of colors from the product that provides the match to the materials.

PART 3 - EXECUTION

3.01 INSPECTION

- A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint sealant performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to

comply with joint sealant manufacturer's written instructions and the following requirements:

1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
 2. Clean concrete, masonry, and similar porous joint substrate surfaces by brushing, grinding, blast cleaning, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air.
 3. Remove laitance and form-release agents from concrete.
 4. Clean metal and similar nonporous surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants.
- B. Joint Priming: Prime joint substrates, where recommended in writing by joint sealant manufacturer, based on prior experience. Apply primer to comply with joint sealant manufacturer's written instructions. Confine primers to areas of joint sealant bond; do not allow spillage or migration onto adjoining surfaces.
- C. Masking Tape: Use masking tape where required to prevent contact of sealant with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.03 JOINT SEALANT INSTALLATION

- A. General: Comply with joint sealant manufacturers' published instructions, unless more stringent requirements are shown or specified, or the manufacturer's technical representative recommends otherwise.
- B. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- C. Prime or seal joint surfaces as indicated or recommended by the sealant manufacturer. Do not spill or allow primers or sealers to migrate onto adjoining surfaces.
- D. Install sealant backer rods for all elastomeric sealants, unless indicated to be omitted or recommended to be omitted by sealant manufacturer for the application shown.
- E. Install bond breaker tape where required by manufacturer's recommendations to ensure that elastomeric sealants will perform properly, or as indicated on the Plans.
- F. Employ only proven installation techniques that will ensure sealants are deposited in uniform, continuous ribbons without gaps or air pockets, with complete "wetting" of the

joint bond surfaces equally on opposite sides. Unless otherwise indicated, fill sealant joints to a slightly concave surface and slightly below adjoining surfaces. Where horizontal joints occur between a horizontal surface and a vertical surface, fill joints to form a slight cove, so that the joint will not trap moisture and dirt.

- G. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
- H. Install sealants to depths indicated, or if not indicated, as recommended by the sealant manufacturer, but within the following general limitations measured at the center (thin) section of the bead.
 - 1. For sidewalks, pavements, and similar joints sealed with elastomeric sealants and subject to traffic and other abrasion and indentation exposure, fill joints to a depth equal to 75 percent of the joint width, but neither more than 5/8 inch deep nor less than 3/8 inch deep.
 - 2. For normal moving joints sealed with elastomeric sealants, but not subject to traffic, fill joints to a depth equal to 50 percent of joint width, but not more than 3/8 inch nor less than 1/4 inch.
 - 3. For joints sealed with non-elastomeric sealant compounds, fill joints to a depth in the range of 75 percent to 115 percent of the joint width.
- I. Do not permit joint sealant materials (primers, sealers, or sealants) to spill onto adjoining surfaces, or be allowed to migrate into the voids of adjoining surfaces including rough textures. Use masking tape or other precautionary devices to prevent staining of adjoining surfaces.
- J. Promptly remove excess sealant from surfaces adjacent to joints as the work progresses. Clean adjoining surfaces as necessary to eliminate evidence of spillage, without damage to the adjoining surfaces or finishes.

3.04 CURE AND PROTECTION

- A. Cure sealants in compliance with the manufacturer's published instructions and current recommendations to obtain high early bond strength, internal cohesive strength, and surface durability.
- B. The installer shall advise the Contractor of procedures required for the curing and protection of sealants compounds during the construction period, so that they will be without deterioration or damage (other than normal wear and weathering), at the time of Final Acceptance.

END OF SECTION 07 92 00

SECTION 08 11 13
HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes:
 - 1. Flush Steel Hollow Metal Doors and frames.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00:
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) Requirements
- B. DOOR HARDWARE: Section 08 71 00.
- C. PAINTING: Section 09 91 00.

1.03 QUALITY ASSURANCE

- A. Approved Products: As applicable, products used herein shall comply with requirements of the Florida Product Approval System as required by Florida Statute 553.842 and Florida Administrative Code 9B-72.
- B. Manufacturer/Fabricator: Steel doors and frames shall be manufactured by a single firm specializing in the production of this type of work.
- C. Reference Standards: Comply with provisions of the following, unless otherwise indicated or specified:
 - 1. American National Standards Institute (ANSI):
 - a. Referenced Standards.
 - 2. American Society for Testing and Materials (ASTM):
 - a. Referenced Standards.
 - 3. Glass Association of North America (GANA):
 - a. Referenced Standards.
 - 4. National Fire Protection Association (NFPA):
 - a. Referenced Standards.
 - 5. Steel Door Institute (SDI):

- a. SDI 100 Recommended Specifications for Standard Steel Doors and Frames.
 - b. SDI 105 Recommended Erection Instructions for Steel Frames.
- D. Fire-Resistance Classifications: Where fire-resistance classifications are shown or scheduled for steel doors and frame assemblies, the doors and frames shall comply with the requirements of NFPA 80, and shall have been tested and rated with the appropriate hardware by Underwriters Laboratories (UL). A UL label shall be provided on each door and frame so classified.
- E. Wind Resistance: Exterior door assemblies shall comply with Florida Building Code Test Protocol TAS 201- Impact and Test Procedures and Test Protocol TAS 203 - Criteria for Testing Products Subject to Cyclic Wind Pressure Loading.

1.04 SUBMITTALS

- A. Product Data: Submit manufacturer's technical information and installation instructions for each type of door and frame.
- B. Shop Drawings: Submit shop drawings for steel doors and frames as follows, and as a package with submittals for other doors and finish hardware to enable a coordinated review of all door openings for the Project.
- 1. Submit shop drawings for the fabrication and installation of the steel doors and frames. Drawings shall include details of each frame type, elevations of door design types, louvers, conditions at openings, details of construction, location and installation requirements of finish hardware, and reinforcements and details of joints and connections, showing anchorage and accessory items.
 - 2. Shop drawings shall indicate accurate dimensions of work shown. Frame returns shall allow for conditions (i.e. 5/8 inch gypsum board or exposed masonry as scheduled). Except where otherwise shown, 1/4 inch sealant space shall be provided for each jamb and head abutting wall materials.
 - 3. Shop drawings shall list and locate all items of finish hardware furnished under other Sections of the Specifications, but prepared for by the manufacturer of hollow metal doors and frames, from templates provided by the hardware supplier.
- C. Schedule:
- 1. A schedule of doors and frames shall be provided using the same opening numbers referenced on the Drawings and the same schedule format.

1.05 PRODUCT DELIVERY AND STORAGE

- A. Doors and frames shall be protected during transit, storage, and handling to prevent damage, soiling, and deterioration.
- B. Each door shall be packaged at the factory in a separate heavy paper carton. Each carton shall be marked for location to correspond with the Shop Drawings.

- C. Ship welded frames in bundles securely strapped or in packages.
- D. Store doors and frames at the building site under cover. Frames shall be stored in an upright position. Place the units on at least 4 inch wood sills or on floors in a manner that will prevent rust or damage. Avoid the use of nonvented plastic or canvas shelters that create a humidity chamber. If the wrapper on the door becomes wet, remove the carton immediately. Provide a 1/4 inch air space between the doors to promote air circulation.

1.06 PROJECT CONDITIONS

- A. Field Measurements: Obtain and verify all measurements at the buildings as required to properly fabricate and install all special door and frame requirements if and when they occur. Verify all conditions that may affect door installation.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Products: Provide one of the following:
 - 1. "Lock Seam Design"; American Steel Products.
 - 2. "Series HT"; Pioneer Industries, Inc.
 - 3. "Series LW"; Steelcraft/Ingersoll Rand.

2.02 MATERIALS AND FABRICATION

- A. Pressed Steel Frames:
 - 1. Frames shall be double rabbeted design, depth and profile as detailed and furnished with minimum 5/8 inch stop. Frames shall be fabricated from 14 gauge (exterior openings) and 16 gauge (interior openings) commercial quality, level, cold-rolled steel conforming to ASTM A 1008 or hot-rolled, pickled and oiled steel conforming to ASTM A 1011.
 - 2. Frames shall have zinc coating applied by hot-dip process conforming to ASTM A 653 (G90) with coating weight not less than 0.60 oz. per square foot (0.30 oz. per square foot per side). Frames shall be designed with integral stop and trim.
 - 3. Frame corners shall be mitered and continuously arc welded (both inside of mitered corners and butt edges) with all exposed welds ground and sanded smooth. Mitered corners shall be reinforced with 18-gauge channel-shaped reinforcements.
 - a. Knockdown frames are not acceptable
 - 4. Head members shall be 2 inches high unless otherwise indicated.
 - 5. Strike jambs shall be provided with three (3) holes for rubber bumpers (silencers); refer to Section 08 71 00 - DOOR HARDWARE for furnishing and installation of silencers.

B. Steel Doors:

1. Hollow metal steel doors shall be fabricated from 18 gauge commercial quality, level, cold-rolled steel conforming to ASTM A 1008 or hot-rolled, pickled and oiled steel conforming to ASTM A 1011. Face sheets for doors shall have zinc coating applied by hot-dip process conforming to ASTM A 653 (G90) with coating weight not less than 0.60 oz. per square foot (0.30 oz. per square foot per side).
2. Door face sheets shall be 1-3/4 inches thick heavy-duty, full flush hollow steel formed from one sheet of metal with no seams permitted on the door face. Lock seam shall occur on hinge edge with seam continuously welded and welds ground smooth. Tops shall be flush and closed with no holes. Top and bottom of door shall be closed with a minimum 16 gauge flush or inverted closure channel.
3. A full-width dense rigid polyurethane core conforming to ASTM C 591 shall be installed in all doors to provide dimensional stability and high resistance to facial impact.
4. The clearances for doors shall be 3/32- to 1/8-inch at jambs and heads. The lock edges of stiles shall be beveled 1/8 inch in 2 inches for steel doors.
5. The top and bottom edges of all exterior steel doors shall be closed to provide a weather seal. This seal shall be provided as part of the door construction or by the addition of inverted steel channels or other suitable shapes welded, caulked and sealed to the face sheets and formed (shaped) so the assembly will not retain water.
6. All exterior double doors shall have a steel astragal attached to the active leaf.

C. Labeled Steel Doors and Frames:

1. Where indicated on Drawings, furnish UL Labels with appropriate fire resistance ratings for the class of opening specified. Both doors and frame shall have label attached. Construction details and hardware application shall be as approved by the labeling authority.
2. All approved fire doors shall be arranged to either remain in normally closed position with suitable self-closing device or in normally open position with a fusible element or smoke detector actuated mechanism which will close the door automatically in case of fire, as indicated on Drawings and/or as required by governing authorities.
3. Pairs of UL label fire doors shall have an overlapping steel astragal welded or bolted to the active leaf.
4. The clearances for fire doors shall be as required by the authority having jurisdiction.

D. Metal Finishes:

1. Shop Applied Primer Finish:

- a. Apply a primed finish to all galvanized and non-galvanized metal surfaces furnished under this Section. Clean and chemically treat metal surfaces to assure maximum paint adhesion; follow with a dip or spray coat of rust-inhibitive metallic oxide, zinc chromate, or synthetic resin primer on all exposed surfaces.
 - b. Finished surfaces shall be smooth and free from irregularities and rough spots. Paint shall be baked or oven dried. the time and temperature for drying shall be in accordance with manufacturer's recommendations for developing maximum hardness and resistance to abrasion.
2. Field Paint Finish: Finish painting of steel doors and frames is specified under Section 09 91 00 - PAINTING.
- E. Hardware Provisions and Reinforcing:
- 1. Hardware Provisions for Pressed Steel Frames:
 - a. Unless a different strike is noted on Hardware Schedule, frames shall have steel hinge plate reinforcement projection welded with provisions for 4-1/2 inch x 4-1/2 inch full mortise type hinges and steel strike tap plate reinforcement projection welded with provisions for Universal ANSI A115.1 or A115.2 strike.
 - b. Frames shall be provided for 1-1/2 pair of hinges, unless noted otherwise. Mortar guards shall be formed from 26-gauge galvanized steel and shall be welded in place.
 - c. Closer reinforcement shall be sleeve type installed in frame header for all doors that are indicated to receive door closers.
 - d. Provide metal reinforcements for all other hardware items indicated.
 - e. Minimum gauges of hardware reinforcing plates shall be as follows:
 - (1) Hinge Reinforcements: 8 gauge, 1-1/4 x 10-inch min. size.
 - (2) Lock Reinforcements: 12 gauge.
 - (3) Closer Reinforcements: 12 gauge.
 - (4) Surface-Mounted Hardware: 12 gauge.
 - 2. Hardware Provisions for Steel Doors:
 - a. Mortise, reinforce, drill and tap doors at the factory to receive all mortised type hardware. Drilling and tapping for surface applied hardware shall be performed in field. Provide concealed metal reinforcement for surface applied hardware indicated in the Hardware Schedule.
 - b. Doors shall have steel integral hinge reinforcement with provisions for 4-1/2 inch x 4-1/2 inch full mortise template type hinges for 1-1/2 pair of

hinges per door, unless noted otherwise.

- c. Doors shall have steel integral lock reinforcement with provisions for locksets as indicated.
 - d. Doors shall have steel closer reinforcement concealed in the door for all doors that are indicated to receive closers.
 - e. Minimum gauges for hardware reinforcing plates shall be as follows:
 - (1) Hinge Reinforcements: 8 gauge.
 - (2) Lock Reinforcements: 12 gauge.
 - (3) Closer Reinforcements: 12 gauge.
 - (4) Surface Mounted Hardware: 16 gauge.
- F. Location of Hardware: The location of hardware in connection with hinged and other swing type hollow metal doors and frames shall be as follows, unless indicated or specified otherwise:
- 1. Top Hinge: To manufacturer's standard, but not greater than 5 inches from head rabbet to top of hinge.
 - 2. Bottom Hinge: To manufacturer's standard but not greater than 10 inches from finish floor to bottom of hinge.
 - 3. Intermediate Hinge: Equally spaced between top and bottom hinge.
 - 4. Locks (cylindrical, mortise, unit or integral): 38 inches from finish floor to center of strike.
 - 5. Refer to Section 08 71 00 - DOOR HARDWARE for additional locations.
- G. Frame Anchors:
- 1. All frames shall have an integral or welded on sill anchor.
 - 2. Furnish six (6) per frame, 10 inch long corrugated or other deformed type adjustable anchors as condition applies.

2.03 FABRICATION

- A. All work shall be shop fabricated to required profiles by forming and welding with corners, angles and edges straight and sharp.
- B. Fit and fabricate accurately with corners, joints, seams and surfaces free from warp, buckles or other defects.

PART 3 - EXECUTION

3.01 INSPECTION

- A. Examine the areas and conditions under which steel doors and frames are to be installed. Do not proceed with steel door and frame installation until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. General: Install standard steel doors, frames and accessories in accordance with approved shop drawings, manufacturer's data and as herein specified.
- B. Steel Frames:
 - 1. Comply with provisions of SDI 105, unless otherwise indicated.
 - 2. Except for frames located at in-place drywall installations, place frames prior to construction of enclosing walls and ceilings. Set frames accurately in position, plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is completed, remove temporary braces and spreaders leaving surfaces smooth and undamaged.
 - 3. In masonry and precast concrete construction, wall anchors shall be located at the hinge and strike levels, and frames shall be grouted solid (Jambs and Heads).
 - 4. Install fire-rated frames in accordance with NFPA 80.
 - 5. In concrete construction, locate three (3) wall anchors per jamb at hinge and strike levels.
- C. Steel Doors:
 - 1. Fit steel doors accurately in frames, within clearances specified in SDI 100.
 - 2. Place fire-rated doors with clearances as specified in NFPA 80.

3.03 ADJUST AND CLEAN

- A. Prime Coat Touch-up: Immediately after installation, sand smooth all rusted or damaged areas of prime coat and apply touch-up of compatible air-drying primer.
- B. Final Adjustments: Check and readjust operating finish hardware items, leaving steel doors and frames undamaged and in complete and proper operating condition.
- C. Cleaning: Immediately prior to final inspection and before Final Acceptance, remove all protective materials and clean all exposed members. Do not use abrasives or harmful cleaning agents.

END OF SECTION 08 11 13

SECTION 08 14 16
FLUSH WOOD DOORS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. SUMMARY OF WORK: Section 01 11 00:
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) Requirements
- B. ALUMINUM-FRAMED ENTRANCES AND STOREFRONTS: Section 08 41 13
- C. DOOR HARDWARE: Section 08 71 00.

1.02 SUMMARY

- A. Section Includes:
 - 1. Solid-core doors with wood-veneer faces.
 - 2. Factory finishing flush wood doors.
 - 3. Factory fitting flush wood doors to frames and factory machining for hardware.

1.03 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of door. Include details of core and edge construction, louvers, and trim for openings. Include factory-finishing specifications.
- B. Shop Drawings: Indicate location, size, and hand of each door; elevation of each kind of door; construction details not covered in Product Data; and the following:
 - 1. Dimensions and locations of blocking.
 - 2. Dimensions and locations of mortises and holes for hardware.
 - 3. Dimensions and locations of cutouts.
 - 4. Undercuts.
 - 5. Requirements for veneer matching.
 - 6. Doors to be factory finished and finish requirements.
 - 7. Fire-protection ratings for fire-rated doors.

- C. Samples for Initial Selection: Material samples for manufacturer's full range of factory finished doors.

1.05 INFORMATIONAL SUBMITTALS

- A. Sample Warranty: For special warranty.
- B. Quality Standard Compliance Certificates: AWI Quality Certification Program certificates.

1.06 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A qualified manufacturer that is certified for chain of custody by an FSC-accredited certification body and is a certified participant in AWI's Quality Certification Program.
- B. Chain-of-custody certification is not required for subcontractors (entities that install products) but is required for vendors unless they are simply acting as an agent of manufacturer and the sale is actually between manufacturer and Contractor or subcontractor.
- C. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Comply with requirements of referenced standard and manufacturer's written instructions.
- B. Package doors individually in cardboard cartons and wrap bundles of doors in plastic sheeting.
- C. Mark each door on bottom rail with opening number used on Shop Drawings.

1.08 FIELD CONDITIONS

- A. Environmental Limitations: Do not deliver or install doors until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during remainder of construction period.
- B. Environmental Limitations: Do not deliver or install doors until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and HVAC system is operating and maintaining temperature between 60 and 90 deg F (16 and 32 deg C) and relative humidity between 43 and 70 percent during remainder of construction period.

1.09 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace doors that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Warping (bow, cup, or twist) more than 1/4 inch (6.4 mm) in a 42-by-84-inch (1067-by-2134-mm) section.

- b. Telegraphing of core construction in face veneers exceeding 0.01 inch in a 3-inch (0.25 mm in a 76.2-mm) span.
2. Warranty shall also include installation and finishing that may be required due to repair or replacement of defective doors.
3. Warranty Period for Solid-Core Interior Doors: Life of installation.

PART 2 - PRODUCTS

2.01 FLUSH WOOD DOORS, GENERAL

- A. Quality Standard: In addition to requirements specified, comply with WDMA I.S.1-A, "Architectural Wood Flush Doors."
 1. Provide AWI Quality Certification Labels indicating that doors comply with requirements of grades specified.
 2. Contract Documents contain selections chosen from options in quality standard and additional requirements beyond those of quality standard. Comply with those selections and requirements in addition to quality standard.
- B. Certified Wood: Flush wood doors shall be certified as "FSC Pure" or "FSC Mixed Credit" according to FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship," and to FSC STD-40-004, "FSC Standard for Chain of Custody Certification."
- C. Low-Emitting Materials: Fabricate doors with adhesives and composite wood products that do not contain urea formaldehyde.
- D. WDMA I.S.1-A Performance Grade:
 1. Heavy Duty unless otherwise indicated.
 2. Extra Heavy Duty: public toilets, janitor's closets, assembly spaces, exits and patient rooms and where indicated.
 3. Standard Duty: Closets (not including janitor's closets) and where indicated.
- E. Fire-Rated Wood Doors (if applicable): Doors complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure according to NFPA 252 or UL 10C.
 1. Oversize Fire-Rated Door Assemblies: For units exceeding sizes of tested assemblies, provide certification by a qualified testing agency that doors comply with standard construction requirements for tested and labeled fire-rated door assemblies except for size.
 2. Temperature-Rise Limit: At vertical exit enclosures and exit passageways, provide doors that have a maximum transmitted temperature end point of not more than 450 deg F (250 deg C) above ambient after 30 minutes of standard fire-test exposure.

3. Cores: Provide core specified or mineral core as needed to provide fire-protection rating indicated.
 4. Edge Construction: Provide edge construction with intumescent seals concealed by outer stile. Comply with specified requirements for exposed edges.
 5. Pairs: Provide fire-retardant stiles that are listed and labeled for applications indicated without formed-steel edges and astragals. Provide stiles with concealed intumescent seals. Comply with specified requirements for exposed edges.
- F. Smoke- and Draft-Control Door Assemblies (if applicable): Listed and labeled for smoke and draft control, based on testing according to UL 1784.
- G. Structural-Composite-Lumber-Core Doors (if applicable):
1. Structural Composite Lumber: WDMA I.S.10.
 - a. Screw Withdrawal, Face: 700 lbf (3100 N).
 - b. Screw Withdrawal, Edge: 400 lbf (1780 N).
- H. Mineral-Core Doors:
1. Core: Noncombustible mineral product complying with requirements of referenced quality standard and testing and inspecting agency for fire-protection rating indicated.
 2. Blocking: Provide composite blocking with improved screw-holding capability approved for use in doors of fire-protection ratings indicated as needed to eliminate through-bolting hardware.
 - a. 5-inch (125-mm) top-rail blocking.
 - b. 5-inch (125-mm) bottom-rail blocking, in doors indicated to have protection plates.
 - c. 5-inch (125-mm) mid-rail blocking, in doors indicated to have armor plates.
 - d. 4-1/2-by-10-inch (114-by-250-mm) lock blocks, in doors indicated to have exit devices.
 3. Edge Construction: At hinge stiles, provide laminated-edge construction with improved screw-holding capability and split resistance. Comply with specified requirements for exposed edges.
 - a. Screw-Holding Capability: 475 lbf (2110 N) per WDMA T.M.-10.

2.02 VENEER-FACED DOORS FOR TRANSPARENT FINISH

- A. Interior Solid-Core Doors:

1. Grade: Premium, with Grade A faces.
2. Species: As selected by Architect and coordinated with selected plywood finish. Provide manufacturer's full range of species.
3. Cut: Plain sliced.
4. Match between Veneer Leaves: Book match.
5. Assembly of Veneer Leaves on Door Faces: Center-balance Balance match.
6. Pair and Set Match: Provide for doors hung in same opening or separated only by mullions.
7. Exposed Vertical and Top Edges: Same species as faces - edge Type A.
8. Core: Structural composite lumber.
9. Construction: Five plies. Stiles and rails are bonded to core, then entire unit is abrasive planed before veneering.
10. Construction: Seven plies, either bonded or non-bonded construction.
11. WDMA I.S.1-A Performance Grade: Heavy Duty.

2.03 FABRICATION

- A. Factory fit doors to suit frame-opening sizes indicated. Comply with clearance requirements of referenced quality standard for fitting unless otherwise indicated.
 1. Comply with NFPA 80 requirements for fire-rated doors.
- B. Factory machine doors for hardware that is not surface applied. Locate hardware to comply with DHI-WDHS-3. Comply with final hardware schedules, door frame Shop Drawings, BHMA-156.115-W, and hardware templates.
 1. Coordinate with hardware mortises in metal frames to verify dimensions and alignment before factory machining.
 2. Metal Astragals: Factory machine astragals and formed-steel edges for hardware for pairs of fire-rated doors.
- C. Transom and Side Panels: Fabricate matching panels with same construction, exposed surfaces, and finish as specified for associated doors. Finish bottom edges of transoms and top edges of rabbeted doors same as door stiles.
 1. Fabricate door and transom panels with full-width, solid-lumber, rabbeted, meeting rails. Provide factory-installed spring bolts for concealed attachment into jambs of metal door frames.

- D. Openings: Factory cut and trim openings through doors.
 - 1. Light Openings: Trim openings with moldings of material and profile indicated.
 - 2. Glazing: Factory install glazing in doors indicated to be factory finished. Comply with applicable requirements in Section 088000 "Glazing."
 - 3. Louvers: Factory install louvers in prepared openings.

2.04 SHOP PRIMING

- A. Doors for Transparent Finish: Shop prime faces and all four edges with stain (if required), other required pretreatments, and first coat of finish per manufacturer's recommended instructions. Seal edges of cutouts and mortises with first coat of finish.

2.05 FACTORY FINISHING

- A. General: Comply with referenced quality standard for factory finishing. Complete fabrication, including fitting doors for openings and machining for hardware that is not surface applied, before finishing.
 - 1. Finish faces, all four edges, edges of cutouts, and mortises. Stains and fillers may be omitted on bottom edges, edges of cutouts, and mortises.
- B. Factory finishes doors that are indicated to receive transparent finish.
- C. Use only paints and coatings that comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- D. Transparent Finish:
 - 1. Grade: Custom.
 - 2. Finish: WDMA TR-4 conversion varnish.
 - 3. Effect: Open-grain finish.
 - 4. Sheen: Satin.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine doors and installed door frames, with Installer present, before hanging doors.
 - 1. Verify that installed frames comply with indicated requirements for type, size, location, and swing characteristics and have been installed with level heads and plumb jambs.
 - 2. Reject doors with defects.

- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Hardware: For installation, see Section 087100 "Door Hardware."
- B. Installation Instructions: Install doors to comply with manufacturer's written instructions and referenced quality standard, and as indicated.
 - 1. Install fire-rated doors according to NFPA 80.
 - 2. Install smoke- and draft-control doors according to NFPA 105.
- C. Job-Fitted Doors: Align and fit doors in frames with uniform clearances and bevels as indicated below; do not trim stiles and rails in excess of limits set by manufacturer or permitted for fire-rated doors. Machine doors for hardware. Seal edges of doors, edges of cutouts, and mortises after fitting and machining.
 - 1. Clearances: Provide 1/8 inch (3.2 mm) at heads, jambs, and between pairs of doors. Provide 1/8 inch (3.2 mm) from bottom of door to top of decorative floor finish or covering unless otherwise indicated. Where threshold is shown or scheduled, provide 1/4 inch (6.4 mm) from bottom of door to top of threshold unless otherwise indicated.
 - a. Comply with NFPA 80 for fire-rated doors.
 - b. Bevel non-fire-rated doors 1/8 inch in 2 inches (3-1/2 degrees) at lock and hinge edges.
 - 2. Bevel fire-rated doors 1/8 inch in 2 inches (3-1/2 degrees) at lock edge; trim stiles and rails only to extent permitted by labeling agency.
- D. Factory-Fitted Doors: Align in frames for uniform clearance at each edge.
- E. Factory-Finished Doors: Restore finish before installation if fitting or machining is required at Project site.

3.03 ADJUSTING

- A. Operation: Rehang or replace doors that do not swing or operate freely.
- B. Finished Doors: Replace doors that are damaged or that do not comply with requirements. Doors may be repaired or refinished if Work complies with requirements and shows no evidence of repair or refinishing.

END OF SECTION 08 14 16

SECTION 08 35 13
BI-FOLDING ALUMINUM FRAMED GLASS WALL SYSTEMS

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Aluminum framed sliding/folding glass wall system, including frame, threshold, panels, sliding/folding and locking hardware, weather stripping, glass and glazing; designed to provide an operable glass wall, with sizes and configurations as shown on drawings.

1.02 RELATED REQUIREMENTS

- A. SUMMARY OF WORK: Section 01 11 00:
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) Requirements
- B. Section 05 12 00 - Structural Steel Framing.
- C. Section 07 90 00 - Joint Protection.
- D. Section 08 80 00 - Glazing: Glass and glazing accessories.

1.03 REFERENCE STANDARDS

- A. American Architectural Manufacturers Association (AAMA):
 - 1. AAMA 611, Voluntary Specification for Anodized Architectural Aluminum.
 - 2. AAMA 2604, Voluntary Specifications, Performance Requirements and Test Procedures for Pigmented Organic Coatings on Aluminum Extrusions and Panels.
- B. American National Standards Institute (ANSI):
 - 1. ANSI Z97.1, Safety Performance Specifications and Methods of Test for Safety Glazing Material Used In Buildings.
- C. American Society for Testing and Materials (ASTM):
 - 1. ASTM E 283, Test Method for Rate of Air Leakage through Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference.
 - 2. ASTM E 330, Test Method for Structural Performance of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference.
 - 3. ASTM E 547, Test Method for Water Penetration of Exterior Windows, Curtain Walls, and Doors by Cyclic Static Air Pressure Differential.
 - 4. ASTM E 331, Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference.

- D. Consumer Product Safety Commission (CPSC):
 - 1. CPSC 16CFR-1201, Safety Standard for Architectural Glazing Materials.
- E. National Fenestration Rating Council (NFRC):
 - 1. NFRC 100, Procedure for Determining Fenestration Product Thermal Materials.
 - 2. NFRC 200, Procedure for Determining Solar Heat Gain Coefficient.
 - 3. NFRC 400, Procedure for Determining Fenestration Product Air Leakage.

1.04 SUBMITTALS

- A. Product Data: Manufacturer's literature including independently tested data listing performance criteria and Owner's Manual with installation instructions.
- B. Shop Drawings: Indicate dimensioning, direction of swing, configuration, swing panels, typical head jamb, side jambs and sill details, type of glazing material, and handle height.
- C. Hardware Schedule: Complete itemization of each item of hardware to be provided for each panel, cross-referenced to panel identification numbers in Contract Documents.
- D. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing aluminum framed bi-folding glass wall systems with a minimum three years of documented experience. Single source manufacturer.
 - 1. The manufacturer must have a quality management system registration to the ISO 9001: 2008 standard.
- B. Installer Qualifications: Installer experienced in the installation of manufacturer's products or other similar products for large openings. Installer to provide reference list of at least 3 projects of similar scale and complexity successfully completed in the last 3 years.
- C. Performance Requirements: Provide from manufacturer that has independently tested typical units.

1.06 WARRANTY

- A. Provide manufacturer's standard warranty against defects in materials and workmanship.
- B. Warranty Period: Three years from date of delivery by manufacturer.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to job site in the manufacturer's original protective cartons or crates. Do not deliver units until the project is ready for their installation.

1. Inspect components for damage upon delivery. Unless minor defects in metal components can be made to meet the Architect's specifications and satisfaction, damaged parts should be removed and replaced.
- B. Protect units from damage. Store material under cover, protected from weather and construction activities.

1.08 PROJECT CONDITIONS

- A. Field measurements: Check opening by accurate field measurement before fabrication. Show recorded measurements on shop drawings. Coordinate fabrication schedule with construction progress to avoid delay of the work and possible damage to the finished product.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURER'S

- A. Basis of design: Design is based on The Monterey S55 Series manufactured by: C.R. Laurence Company (CRL)

2.02 MATERIALS

- A. A. Frame and Panels: From manufacturer's standard profiles, provide head track, side jambs, and panels with dimensions shown on drawings.
 1. Provide panels with: Standard one lite.
 2. Provide standard bottom rail.
 3. Aluminum Extrusion: Extrusions with nominal thickness of .078" (2.0 mm). Anodized conforming to AAMA 611 or powder coated conforming to AAMA 2604.
 4. Aluminum Finish: Select from Standard black powder coat.
- B. Glass:
 1. All glass to comply with safety glazing requirements of ANSI Z97.1 and CPSC 16CFR 1201. Provide manufacturer's standard glass with dry glazing with glass stops on the inside only: 1/4 inch (6 mm) clear monolithic tempered
- C. Locking Hardware and Handles:
 1. Main entry panel: Do not provide lock.
- D. Sliding/Folding Hardware: Provide manufacturer's standard combination sliding and folding hardware with top and bottom tracks and threshold.
- E. Maximum weight per leaf:
 1. For S55 Series 100 pounds (45 kg).

- F. Adjustment: Provide system capable of adjustments without removing panels from tracks.
- G. Other Components:
 - 1. Weather stripping: Provide manufacturer's standard non-broken EPDM seals between panels, and between panel and frame.

2.03 FABRICATION

- A. Use extruded aluminum frame and panel profiles with hinges, sliding, and folding hardware, locking hardware and handles, glass and glazing and weather stripping as specified herein to make a folding glass wall. Factory pre-assemble as is standard for manufacturer and ship with all components and installation instructions.
- B. Sizes and Configurations: See drawings for selected custom dimensions within maximum frame sizes possible as indicated in manufacturer's literature. See drawings for selected number of panels and configuration. Inward [OR outward] opening unit. On configurations with a swing panel, looking from inside, primary swing panel on the left [OR right].

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify dimensions, tolerances, and method of attachment with other work.
- B. Verify that wall openings and adjoining air and vapor seal materials are ready to receive work of this section.

3.02 INSTALLATION

- A. Install bi-folding glass wall system in accordance with manufacturer's instructions.
- B. Attach to structure to permit sufficient adjustment to accommodate construction tolerances and other irregularities.
- C. Provide alignment attachments and shims to permanently fasten system to building structure.
- D. Align assembly plumb and level, free of warp or twist. Maintain assembly dimensional tolerances, aligning with adjacent work.
- E. Provide thermal isolation where components penetrate or disrupt building insulation.
- F. Install sill flashings. Turn up ends and edges; seal to adjacent work to form water tight dam.
- G. Where fasteners penetrate sill flashings, make watertight by seating and sealing fastener heads to sill flashing.
- H. Coordinate attachment and seal of perimeter air and vapor barrier materials.
- I. Pack fibrous insulation in shim spaces at perimeter of assembly to maintain continuity of

thermal barrier.

- J. Set thresholds in bed of mastic and secure.
- K. Install glass and infill panels in accordance with Section 08 8000, using glazing method required to achieve performance criteria.
- L. Install perimeter sealant in accordance with Section 07 9005.
- M. Touch-up minor damage to factory applied finish; replace components that cannot be satisfactorily repaired.

3.03 TOLERANCES

- A. Maximum Variation from Plumb: 0.06 inches every 3 ft (1.5 mm/m) non-cumulative or 1/16 inches per 10 ft (1.5 mm/3 m), whichever is less.
- B. Maximum Misalignment of Two Adjoining Members Abutting in Plane: 1/32 inch (0.8 mm).

3.04 ADJUSTING

- A. Adjust operating hardware and leaf for smooth operation.

3.05 CLEANING

- A. Remove protective material from pre-finished aluminum surfaces.
- B. Wash down surfaces with a solution of mild detergent in warm water, applied with soft, clean wiping cloths. Take care to remove dirt from corners. Wipe surfaces clean.
- C. Remove excess sealant by method acceptable to sealant manufacturer.

3.06 PROTECTION

- A. Protect installed products from damage during subsequent construction.

END OF SECTION 08 35 13

SECTION 08 41 13
ALUMINUM-FRAMED ENTRANCES AND STOREFRONTS

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes exterior aluminum-framed entrances and entrance doors.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00:

1. Refer to "PART 2 – PRODUCTS" for all Buy America Build America Act (BABA) Requirements

- B. JOINT SEALANTS: Section 07 92 00.

- C. HOLLOW METAL DOORS AND FRAMES: Section 08 11 13.

- D. DOOR HARDWARE: Section 08 71 00.

- E. GLASS AND GLAZING: Section 08 81 00.

- F. LC PRIVACY GLASS – Section 08 88 36.

1.03 QUALITY ASSURANCE

- A. Approved Products: As applicable, products used herein shall comply with requirements of the Florida Product Approval System as required by Florida Statute 553.842 and Florida Administrative Code 9B-72.

- B. Code Compliance: Total installation must comply with the requirements of the Florida Building Code, latest adopted edition, as amended, including Test Protocols for High Velocity Hurricane Zones.

- C. Wind Loads: Installed windows to withstand wind pressure loads (positive and negative) normal to wall plane indicated in accordance with the Florida Building Code for the geographical location of the Project.

- D. Installer Qualifications: Capable of assuming engineering responsibility and performing work of this Section and who is acceptable to manufacturer.

1. Engineering Responsibility: Preparation of data for aluminum-framed systems including shop drawings based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project and submission of reports of tests performed on manufacturer's standard assemblies.

- E. Testing Agency Qualifications: An independent agency qualified according to ASTM E 699 for testing indicated.

- F. Accessible Entrances: Comply with the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA), Accessibility Guidelines for Buildings and Facilities (ADAAG)."
- G. Welding: Qualify procedures and personnel according to AWS D1.2 "Structural Welding Code - Aluminum."

1.04 PERFORMANCE REQUIREMENTS

- A. General: Provide aluminum-framed systems, including anchorage, capable of withstanding, without failure, the effects of the following:
 - 1. Structural loads.
 - 2. Thermal movements.
 - 3. Movements of supporting structure indicated on Drawings including, but not limited to, deflection from uniformly distributed and concentrated live loads.
 - 4. Dimensional tolerances of building frame and other adjacent construction.
 - 5. Interior Walls (Pressure Acting in Either Direction)
 - 6. Failure includes the following:
 - a. Deflection exceeding specified limits.
 - b. Thermal stresses transferred to building structure.
 - c. Framing members transferring stresses, including those caused by thermal and structural movements, to glazing.
 - d. Noise or vibration created by wind and thermal and structural movements.
 - e. Loosening or weakening of fasteners, attachments, and other components.
 - f. Sealant failure.
 - g. Failure of operating units to function properly.
- B. Deflection of Framing Members:
 - 1. Deflection Normal to Wall Plane: Limited to 1/175 of clear span or an amount that restricts edge deflection of individual glazing lites to 3/4 inch, whichever is less.
 - 2. Deflection Parallel to Glazing Plane: Limited to 1/360 of clear span or 1/8 inch, whichever is smaller.
- C. Structural Test Performance: Provide aluminum-framed systems tested according to ASTM E 330 as follows:
 - 1. When tested at positive and negative wind load design pressures, systems do not

evidence deflection exceeding specified limits.

2. When tested at 150 percent of positive and negative wind load design pressures, systems, including anchorage, do not evidence material failures, structural distress, and permanent of main framing members exceeding 0.2 percent of span.
 3. Test Durations: As required by design wind velocity but not less than 10 seconds.
- D. Windborne-Debris-Impact-Resistance-Test Performance: Provide aluminum-framed systems that pass large and small missile-impact tests and cyclic-pressure tests according to Florida Building Code, latest adopted edition, as amended.
- E. Thermal Movements: Provide aluminum-framed systems that allow for thermal movements from the following maximum change (range) in ambient and surface temperatures. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
1. Temperature Change (Range): 120 deg F ambient; 180 deg F, material surfaces.
 2. Test Performance: No buckling; stress on glass; sealant failure; excess stress on framing, anchors, and fasteners; or reduction of performance when tested according to AAMA 501.5.
 - a. Test High Exterior Ambient Air Temperature: That which produces an exterior metal surface temperature of 180 deg F.
 - b. Test Low Exterior Ambient Air Temperature: 0 deg F.
- F. Water Penetration Under Dynamic Pressure: Provide aluminum-framed systems that do not evidence water leakage through fixed glazing and framing areas when tested according to AAMA 501.1 under dynamic pressure equal to 20 percent of positive wind load design pressure, but not less than 6.24 lbf/sq. ft..
1. Maximum Water Leakage: According to AAMA 501.1. Water controlled by flashing and gutters that is drained to exterior and cannot damage adjacent materials or finishes is not considered water leakage.
- G. Condensation Resistance: Provide aluminum-framed systems with fixed glazing and framing areas having condensation resistance factor (CRF) of not less than 54 when tested according to AAMA 1503.
- H. Average Thermal Conductance: Provide aluminum-framed systems with fixed glazing and framing areas having average U-factor of not more than 0.48 But/sq. ft. x h x deg F when tested according to AAMA 1503.

1.05 SUBMITTALS

- A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of product indicated.
- B. Shop Drawings: For aluminum-framed systems. Include plans, elevations, sections, details,

and attachments to other work.

1. Include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 2. Include details of provisions for system expansion and contraction and for draining moisture occurring within the system to the exterior.
 3. For entrances, include hardware schedule and indicate operating hardware types, functions, quantities, and locations.
- C. Samples for Verification: For each type of exposed finish required, in manufacturer's standard sizes.
- D. Welding certificates.
- E. Qualification Data: For Installer and testing agency.
- F. Field quality control test and inspection reports.
- G. Maintenance Data: For aluminum-framed system to include in maintenance manuals.
- H. Warranties: Special warranties specified in this Section.

1.06 PROJECT CONDITIONS

- A. Field Measurements: Verify actual locations of structural supports for aluminum-framed systems by field measurements before fabrication and indicate measurements on shop drawings.

1.07 WARRANTY

- A. Special Assembly Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of aluminum-framed systems that do not comply with requirements or that deteriorate as defined in this Section within the specified warranty period.
1. Failures include, but are not limited to, the following:
 - a. Structural failures including, but not limited to, excessive deflection.
 - b. Noise or vibration caused by thermal movements.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
 - d. Water leakage through fixed glazing and framing areas.
 - e. Failure of operating components to function properly.
 2. Warranty Period: Two years from date of Final Acceptance.

- B. Special Finish Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components on which finishes fail within specified warranty period. Warranty does not include normal weathering.
 - 1. Warranty Period: 20 years from date of Final Acceptance.

PART 2 - PRODUCTS

2.01 MANUFACTURER/SYSTEM

- A. Subject to compliance with requirements, aluminum entrance and storefront system shall be as follows:
 - 1. Exterior:
 - a. Basis of Design: YKK YHS 50 TU Thermally Broken, Impact Resistant and Blast Mitigating Storefront System.
 - b. Basis of Design: YKK 35H, Impact Resistant and Blast Mitigating Storefront Entrance System.
 - 2. Interior:
 - a. Basis of Design: YKK AP Series YES 45 FS Storefront System (Monolithic Glazing).
 - b. Basis of Design: YKK AP Series 35D Medium Stile Swing Entrances.

2.02 MATERIALS

- A. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
 - 1. Sheet and Plate: ASTM B 209, Alloy 5005-H16.
 - 2. Extruded Bars, Rods, Profiles, and Tubes: ASTM B 221, Alloy 6063-T6.
 - 3. Extruded Structural Pipe and Tubes: ASTM B 429.
 - 4. Structural Profiles: ASTM B 308.
 - 5. Welding Rods and Bare Electrodes: AWS A5.10.
- B. Steel Reinforcement: With manufacturer's standard corrosion-resistant primer complying with SSPC-PS Guide No. 12.00 applied immediately after surface preparation and pretreatment. Select surface preparation methods according to recommendations in SSPC-SP COM and prepare surfaces according to applicable SSPC standard.

2.03 FRAMING SYSTEMS

- A. Framing Members: Manufacturer's standard extruded aluminum framing members of thickness required and reinforced as required to support imposed loads.

1. Construction: Framing members are composite assemblies of two separate extruded aluminum components permanently bonded by an elastomeric material of low thermal conductance.
- B. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with non-staining, nonferrous shims for aligning system components.
- C. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, nonstaining, non-bleeding fasteners and accessories compatible with adjacent materials.
 1. Where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration, use self-locking devices.
 2. Reinforce members as required to retain fastener threads.
 3. Use exposed fasteners with countersunk Phillips screw heads, finished to match framing system.
- D. Concrete and Masonry Inserts: Hot-dip galvanized cast iron, malleable iron, or steel inserts complying with ASTM A 123 or ASTM A 153 requirements.
- E. Flashing: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding flashing compatible with adjacent materials. Form exposed flashing from sheet aluminum finished to match framing and of sufficient thickness to maintain a flat appearance without visible deflection.
- F. Framing System Gaskets and Sealants: Manufacturer's standard recommended by manufacturer for joint type.
- G. Provide architectural extruded mullions as shown on the plans.

2.04 GLAZING SYSTEMS

- A. Glass: As specified in Section 08 81 80 - GLASS AND GLAZING.
- B. Glazing Gaskets: Manufacturer's standard compression types, replaceable, molded or extruded, that maintain uniform pressure and watertight seal.
- C. Spacers and Setting Blocks: Manufacturer's standard elastomeric types.
- D. Bond-Breaker Tape: Manufacturer's standard TFE-fluorocarbon or polyethylene material to which sealants will not develop adhesion.

2.05 DOORS

- A. Doors: Manufacturer's standard glazed doors, for manual swing operation.
 1. Door Construction: 1-3/4-inch overall thickness, with minimum 0.125 inch thick, extruded aluminum tubular rail and stile members. Mechanically fasten corners with reinforcing brackets that are deep penetration and fillet welded or that incorporate concealed tie rods.

2. Door Design: Medium stile as described herein.
 - a. Accessible Doors: Smooth surfaced for width of door in area within 10 inches above floor or ground plane.
3. Glazing Stops and Gaskets: Beveled, snap-on, extruded aluminum stops and preformed gaskets.
 - a. Provide non-removable glazing stops on outside of door.

2.06 DOOR HARDWARE

- A. General: Provide heavy-duty units in sizes types recommended by entrance system and hardware manufacturers for entrances and uses indicated.
 1. Opening-Force Requirements, Egress Doors: Not more than 30 lbf required to set door in motion and not more than 15 lbf required to open door to minimum required width.
- B. Continuous-Gear Hinges: Manufacturer's standard with stainless steel bearings between knuckles; fabricated to full height of door and frame.
- C. Locking Devices, General: Do not require use of key, tool, or special knowledge for operation.
 1. Opening-Force Requirements:
 - a. Delayed-Egress Locks: Lock releases within 15 seconds after applying a force of not more than 15 lbf for not more than 3 seconds.
 - b. Latches and Exit Devices: Not more than 15 lbf required to release latch.
- D. Panic Exit Devices: Listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for panic protection, based on testing according to UL 305.
 1. Standard: BHMA A156.3, Grade 1.
- E. Cylinders: As specified in Section 08 71 00 - DOOR HARDWARE.
- F. Strikes: Provide strike with black plastic dust box for each latch or lock bolt; fabricated for aluminum framing.
- G. Operating Trim: BHMA A156.6.
- H. Closers: With accessories required for a complete installation, sized as required by door size, exposure to weather, and anticipated frequency of use, and adjustable to meet field conditions and requirements for opening force.
 1. Standard: BHMA A156.4, Grade 1.
- I. Weather Stripping: Manufacturer's standard replaceable components.

1. Compression Type: Made of ASTM D 2000, molded neoprene, or ASTM D 2287, molded PVC.
 2. Sliding Type: AAMA 701, made of wool, polypropylene, or nylon woven pile with nylon-fabric or aluminum-strip backing.
- J. Weather Sweeps: Manufacturer's standard exterior door bottom sweep with concealed fasteners on mounting strip.
- K. Thresholds: Raised thresholds beveled with a slope of not more than 1:2, with maximum height of 2 inch.

2.07 ACCESSORY MATERIALS

- A. Joint Sealants: For installation at perimeter of aluminum-framed systems, as specified in Section 07 92 00 - JOINT SEALANTS.
- B. Bituminous Paint: Cold-applied asphalt-mastic paint complying with SSPC-Paint 12 requirements except containing no asbestos, formulated for 30-mil thickness per coat.

2.08 FABRICATION

- A. Form aluminum shapes before finishing.
- B. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.
- C. Framing Members, General: Fabricate components that, when assembled, have the following characteristics:
1. Profiles that are sharp, straight, and free of defects or deformation.
 2. Accurately fitted joints with ends coped or mitered.
 3. Means to drain water passing joints, condensation occurring within framing members, and moisture migrating within the system to exterior.
 4. Physical and thermal isolation of glazing from framing members.
 5. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
 6. Provisions for field replacement of glazing from exterior.
 7. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.
- D. Mechanically Glazed Framing Members: Fabricate for flush glazing (without projecting stops).

- E. Door Frames: Reinforce as required to support loads imposed by door operation and for installing hardware:
 - 1. At exterior doors, provide compression weather stripping at fixed stops.
- F. Doors: Reinforce doors as required for installing hardware.
 - 1. At pairs of exterior doors, provide sliding weather stripping retained in adjustable strip mortised into door edge.
 - 2. At exterior doors, provide weather sweeps applied to door bottoms.
- G. Hardware Installation: Factory install hardware to the greatest extent possible. Cut, drill, and tap for factory-installed hardware before applying finishes.
- H. After fabrication, clearly mark components to identify their locations in Project according to shop drawings.

2.09 ALUMINUM FINISHES

- A. General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations relative to applying and designating finishes.
- B. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
- C. Finish: Clear Anodized Per Manufacturer
 - 1. Shall meet AAMA 612 criteria for finish, strength, and durability.
 - 2. 10 Year Finish Warranty

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of work.
 - 1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. General:
 - 1. Comply with manufacturer's written instructions.
 - 2. Do not install damaged components.
 - 3. Fit joints to produce hairline joints free of burrs and distortion.
 - 4. Rigidly secure non-movement joints.

5. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration.
 6. Seal joints watertight, unless otherwise indicated.
- B. Metal Protection:
1. Where aluminum is in contact with dissimilar metals, protect against galvanic action by painting contact surfaces with primer or by applying sealant or tape or installing nonconductive spacers as recommended by manufacturer for this purpose.
 2. Where aluminum is in contact with concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.
- C. Install components to drain water passing joints, condensation occurring within framing members, and moisture migrating within the system to exterior.
- D. Set continuous sill members and flashing in a full bed of sealant as specified in Section 07 92 00 - JOINT SEALANTS.
- E. Install components plumb and true in alignment with established lines and grades, without warp or rack.
- F. Install glazing as specified in Section 08 81 00 - GLASS AND GLAZING.
- G. Entrances: Install to produce smooth operation and tight fit at contact points.
1. Exterior Entrances: Install to produce tight fit at weather stripping and weathertight closure.
 2. Field-Installed Hardware: Install surface-mounted hardware according to hardware manufacturers' written instructions using concealed fasteners to greatest extent possible.
- H. Install perimeter joint sealants as specified in Section 07 92 00 - JOINT SEALANTS and to produce weathertight installation.
- I. Erection Tolerances: Install aluminum-framed systems to comply with the following maximum tolerances:
1. Location and Plane: Limit variation from true location and plane to 1/8 inch in 12 feet; 1/4 inch over total length.
 2. Alignment:
 - a. Where surfaces abut in line, limit offset from true alignment to 1/16 inch.
 - b. Where surfaces meet at corners, limit offset from true alignment to 1/32 inch.
 3. Diagonal Measurements: Limit difference between diagonal measurements to 1/8

inch.

3.03 FIELD QUALITY CONTROL

- A. Repair or remove work where inspections indicate that it does not comply with specified requirements.
- B. Additional inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.04 ADJUSTING

- A. Entrances: Adjust operating hardware for smooth operation according to hardware manufacturers' written instructions. For doors accessible to people with disabilities, adjust closers to provide a 3-second closer sweep period for doors to move from a 70-degree open position to 3 inches from the latch measured to the leading door edge.

END OF SECTION 08 41 13

SECTION 08 71 00
DOOR HARDWARE

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes:
 - 1. Finish hardware including electrified hardware for doors as shown on the Plans, indicated on schedules, and as specified herein.
 - 2. Hardware for labeled openings shall meet UL requirements whether specified herein or not.
 - 3. All hardware on accessible doors shall meet or exceed the requirements of the Americans with Disabilities Act (ADA) whether or not full compliance is indicated in the Hardware Schedule located at the end of this Section.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00:
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) Requirements
- B. HOLLOW METAL DOORS AND FRAMES: Section 08 11 13.
- C. ALUMINUM FRAMED ENTRANCES AND STOREFRONTS: Section 08 41 13.

1.03 QUALITY ASSURANCE

- A. Code Compliance: Total installation must comply with the requirements of the Florida Building Code, current edition in force, including Test Protocols for High Velocity Hurricane Zones.
- B. Approved Products: As applicable, products used herein shall comply with requirements of the Florida Product Approval System as required by Florida Statute 553.842 and Florida Administrative Code 9B-72.
- C. Reference Standards: Comply with provisions of the latest adopted editions of the following:
 - 1. Door and Hardware Institute (DHI):Referenced Standards.
 - 2. National Fire Protection Association (NFPA):
 - a. NFPA 80 Fire Doors and Fire Windows.
 - b. NFPA 101 Life Safety Code.
- D. Installer Qualifications: An experienced installer who has completed finish hardware

similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

1.04 SUPPLIER QUALIFICATIONS

- A. Finish Hardware shall be furnished by one supplier, approved by the Engineer, with appropriate technical knowledge and experience to correctly interpret Drawings and Specifications. Supplier shall be prepared at all times during progress of installation to promptly provide a qualified Architectural Hardware Consultant (AHC) to approve its complete installation, in order that all items shall be installed in the best manner and function properly. This will necessitate a project site visit prior to final inspection. Supplier shall be bona-fide direct distributor of all materials furnished.
- B. It shall be the supplier's responsibility to furnish hardware in accordance with the intent of this specification. Where, by virtue of architectural design or by function, a change is necessary, hardware of equal design and quality shall be furnished upon written approval of Engineer.

1.05 SUBMITTALS

- A. Product Data: Submit complete product data for each item of finish hardware listed in the Finish Hardware Schedule. Include installation details, material descriptions, dimensions of individual components and profiles, and finishes.
- B. Finish Hardware Schedule: Submit complete typewritten sets of the Finish Hardware Schedule. Organize the Hardware Schedule into door hardware sets indicating complete designations of every item required for each door. Organize door hardware sets in the same order as in Article 3.03 - FINISH HARDWARE SCHEDULE. No factory order shall be placed for finish hardware items until approval has been given by the Engineer.
 - 1. Each item in the Finish Hardware Schedule shall be identified on the first page of the Schedule by the manufacturer's name.
- C. Keying Schedule: Submit a keying schedule prepared by the supplier, detailing the Owner's keying instructions for locks. Include a schematic keying diagram and index each key to unique door designations. Refer to keying schedule at the end of this Section for additional information.
- D. Supplier Qualifications:
 - 1. Submit documented evidence of supplier's qualifications.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. All items of finish hardware shall be delivered to the Project site, or as otherwise specified or required, and shall be checked in for completeness and familiarization with the Contractor.
- B. All items of finish hardware shall be packaged, numbered, and labeled to identify each opening for which it is intended, and to correspond with item numbers on the approved Finish Hardware Schedule.

1.07 COORDINATION

- A. Templates: All finish hardware to be installed on, or in metal doors and/or frames, shall be manufactured to template. Template machine screws shall be furnished for all such materials. Supplier shall furnish an approved Finish Hardware Schedule and all necessary template transmittals to metal frame fabricators, or other suppliers requiring same, for their coordination and use.

PART 2 - PRODUCTS

2.01 GENERAL

- A. An asterisk (*) after a manufacturer's name denotes whose product designation is used in the Finish Hardware Schedule for purposes of establishing minimum requirements.
- B. Other than those doors that are restricted to less than 180 degree opening by building or by overhead holders or stops, all butts and closer arms shall be of sufficient size to allow full 180-degree opening of doors.

2.02 FINISHES

- A. Butts - Exterior: US32D
- B. Butts - Interior: US26D
- C. Locks: US32D
- D. Closers: SBL
- E. Door Stops and Miscellaneous: US26D

2.03 LOCATIONS

- A. Hardware locations dimension shall be as follows:
 - 1. Distance from finish floor to center line of:
 - a. Door Knob or Lever: 38 inches.
 - b. Door Pull: 42 inches.
 - c. Deadlock: 60 inches.
 - 2. Butt Hinges:
 - a. Bottom Hinge: Finish floor to bottom of hinge 10 inches.
 - b. Top Hinge: Head rabbet to top of hinge 5 inches.
 - c. Center Hinge: Equidistant between top and bottom hinges.

2.04 BUTT HINGES

- A. Doors (1-3/4 Inch Thick): Minimum 4-1/2 inches high.
- B. Each door shall not have less than three hinges.
- C. All butts used with door closers shall be ball bearing. All exterior doors shall have ball bearing butts, except as otherwise specified.
- D. All exterior out-swinging doors shall have butts with non-removable pins (NRP).
- E. Products: Provide butt hinges by one of the following manufacturers:
 - 1. Hager Companies.
 - 2. Stanley Commercial Hardware Div. of The Stanley Works.
 - 3. McKinney Products Co. Div. of ESSEX Industries, Inc.
 - 4. Lawrence Brothers, Inc.

2.05 LOCKSETS

- A. Locksets shall be mortised type with interchangeable core furnished in the functions as specified in the hardware sets.
- B. Levers, escutcheons, locksets and cylinders shall be the products of one manufacturer.
- C. Minimum wall thickness of levers and roses shall be .101 inch and .099 inch, respectively.
- D. All latch bolts shall have 3/4 inch throw. All deadbolts shall have hardened steel inserts and 1 inch throw.
- E. Products: Provide one of the following:
 - 1. Basis of Design: Corbin Russwin "Series ML2000" lockset and "LWA" handle design.

2.06 EXIT DEVICES (IF APPLICABLE)

- A. All exit devices shall be listed under "Panic Hardware" in accident equipment list of Underwriters' Laboratories (UL).
- B. All labeled doors with "Fire Exit Hardware" shall have labels attached and be in strict accordance with UL requirements.
- C. All exit devices shall be tested to ANSI/BHMA A156.3 test requirements by a BHMA certified testing laboratory. A written certification showing successful completion of a minimum of 1,000,000 cycles shall be provided.
- D. Electrified-controlled exit devices shall be UL Listed.

- E. All surface strikes shall be roller type and come complete with a plate underneath to prevent movement, and shall be provided with a dead-latching feature to prevent latchbolt tampering.
- F. Products: Provide one of the following:
 - 1. Basis of Design: Corbin Russwin 5000 Series, for mortised installation with interchangeable core, as applicable, in types and functions specified. Provide ED5000 Series for electrified exit devices.

2.07 KEYING/KEY CONTROL SYSTEM

- A. Keying: All locks shall be Master Keyed as indicated.

2.08 CLOSERS/AUTOMATIC OPENERS

- A. Closers shall be provided in the manufacturer's recommended printed size for specified installation condition, unless otherwise noted in the Finish Hardware Schedule.
- B. Closers shall be full rack and pinion complete with back check. Springs shall be motor clock type. Furnish flush mount transom brackets where no transom bar exists. Furnish parallel arm where required.
- C. All closers shall be provided with limited opening resistance to meet handicap requirements.
- D. Furnish drop plate brackets where required.
- E. Closer at exterior doors shall be installed on the inside of the building.
- F. Products: Provide one of the following:
 - 1. "Series 1430" exterior and "Series 1431" interior closers; Sargent Manufacturing Company Div. of ESSEX Industries, Inc.*
 - 2. "Series 8501"; Norton Door Controls Div. of Yale Security Inc.
 - 3. An equivalent product by one of the following manufacturers:
 - a. Corbin Russwin Architectural Hardware Div. of Yale Security Inc.
 - b. LCN Closers, An Ingersoll-Rand Company.

2.09 DOOR STOPS

- A. Products: Provide door stop types as follows:
 - 1. Products by H.B. Ives:.*
 - a. Wall: "No. 407-1/2."
 - b. Floor: "No. 436."

- c. Floor at Door with Threshold: "No. 438."
 - 2. Products by Rockwood Manufacturing Company:
 - a. Wall: "No. 409."
 - b. Floor: "No. 441."
 - c. Floor at Door with Threshold: "No. 443."
- B. Other Products: Equivalent products by one of the following manufacturers are also acceptable:
 - 1. Glynn-Johnson, An Ingersoll-Rand Company.
 - 2. Russwin Corbin Architectural Hardware Div. of Yale Security Inc.

2.10 SILENCERS

- A. All interior metal door frames shall have door silencers, three (3) per single door, six (6) per pair of doors.
- B. Products: Provide one of the following silencer types:
 - 1. "Type 20"; H.B. Ives.*
 - 2. "Type 64"; Glynn-Johnson, An Ingersoll-Rand Company.
 - 3. "No. 608"; Rockwood Manufacturing Company.

2.11 WEATHERSTRIPPING

- A. General: Continuous weatherstripping shall be installed at each edge of every exterior door leaf. Provide non-corrosive fasteners as recommended by manufacturer for application indicated. Include door top protection (drip caps) for exterior doors where scheduled or as required.
- B. Replaceable Seal Strips: Provide only those units where resilient or flexible seal strip is easily replaceable and readily available from stocks maintained by manufacturer.
- C. Weatherstripping at Jambs and Heads: Bumper-type resilient insert and metal retainer strips, surface-applied. Extruded aluminum retainer, natural anodized finish; closed cell EPDM sponge neoprene insert, except vinyl insert for door shoes.
- D. Products: Provide one the following products:
 - 1. "319CR"; Pemko Manufacturing Co.
 - 2. Other Products: Equivalent products by one of the following manufacturers are also acceptable:
 - a. Zero International, Inc.

- b. Reese Enterprises, Inc.

2.12 THRESHOLDS AND DOOR BOTTOMS

- A. General: Extruded aluminum units, vinyl insert, of type, size and profile as shown or scheduled. Provide thresholds at labeled doors where required by Code, whether specified or not. Product to be of one of the following manufacturers.
- B. Products, Thresholds: Provide one of the following:
 - 1. “272A with 282A Elevator”; Pemko Manufacturing Co., Inc.
 - 2. Other Products: Equivalent products by one of the following manufacturers are also acceptable:
 - a. Zero International, Inc.
 - b. Reese Enterprises, Inc.
- C. Products, Door Bottoms: Provide one of the following:
 - 1. “315CN”; Pemko Manufacturing Co., Inc.
 - 2. Other Products: Equivalent products by one of the following manufacturers are also acceptable:
 - a. Zero International, Inc.
 - b. Reese Enterprises, Inc.

2.13 DRIP CAPS

- A. Install on all exterior doors not under cover as scheduled.
- B. Products: Provide one of the following:
 - 1. “346 AL”; Pemko Manufacturing Co., Inc.
 - 2. Other Products: Equivalent products by one of the following manufacturers are also acceptable:
 - a. Zero International, Inc.
 - b. Reese Enterprises, Inc.

2.14 FASTENERS

- A. Provide door hardware manufactured to comply with published templates generally prepared for machine, wood, and sheet metal screws. Provide screws according to commercially recognized industry standards for application intended. Provide Phillips flat-head screws with finished heads to match surface of door hardware.

2.15 CARD READER

- A. Coordinate with owner for electronic card reader locations and requirements.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine doors and frames, with Installer present, for compliance with requirements for installation tolerances, labeled fire door assembly construction, wall and floor construction, and other conditions affecting performance.
- B. Examine roughing-in for electrical power systems to verify actual locations of wiring connections before electrified door hardware installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Preparation: Comply with the following:
 - 1. Steel Doors and Frames: Comply with Door and Hardware Institute (DHI) A115 Series, "Specifications for Steel Door and Frame Preparation for Hardware (ANSI)."
- B. Mount hardware units at heights indicated in the following applicable publications, except as specifically listed herein under Article 2.03 LOCATIONS, and/or otherwise directed by the Engineer and required to comply with governing regulations.
 - 1. Steel Doors and Frames: Comply with DHI "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."
- C. Install each hardware item in compliance with the manufacturer's published instructions and current recommendations. Where cutting and fitting is required to install hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and re-installation or application of surface protection with finishing work specified in Division 09 Sections. Do not install surface-mounted items until finishes have been completed on the substrates involved.
 - 1. Set units level, plumb, and true to line and location. Adjust and reinforce the attachment substrate as necessary for proper installation and operation.
 - 2. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors in accordance with industry standards.
 - 3. Re-install designated hardware for doors indicated on Drawings. Repair and/or replace hardware as required to provide a complete operable, secure closure.
- D. Set thresholds for exterior doors in full bed of butyl-rubber or polyisobutylene mastic sealant.
- E. Adjust and check each operating item of hardware and each door to ensure proper operation

or function of every unit. Replace units that cannot be adjusted to operate freely and smoothly or as intended for the application made.

- F. Coordinate with electrical installer for connections for power actuated hardware devices.
- G. Clean adjacent surfaces soiled by hardware installation. Clean operating items as necessary to restore proper function and finish.

3.03 FINISH HARDWARE SCHEDULE

- A. The following hardware set(s) are based on door location types as indicated. Refer to Drawings for specific door numbers, sizes, types, and swings. Hardware manufacturers/models shown are “Basis of Design” indicative of type and quality required.
- B. Refer to electrical plans for door operator locations.
- C. Door Hardware Index:

Door #	Group #		Door #	Group #
101	05		127	24
102	05		128	25
103	05		129	19
104	05		130	13
105	05		131	25
106	15		132A	04
107A	15		132B	17
107B	15		133	14
108A	23		134	23
108B	07		136.1	13
109	23		136A	08
110	26		136B	14
112	21		137	23
113	23		139	05
114	25		140	05
115.2	23		141	05
115A	23		142	05
115B	23		143	05
116	25		144	05
117	25		145	05
118	05		146	05
119A	01		147A	12
119B	03		147B	12
120	02		149A	20
120.3	02		149B	10
121	06		150A	16
122	06		150B	09
123	06		151	11
124	23		152	18
126	24		153	22
127	24			

HARDWARE GROUP NO. 01

Provide each PR door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
2	EA	CONT. HINGE	112XY EPT	628	IVE
2	EA	POWER TRANSFER	EPT10	689	VON
1	EA	ELEC PANIC HARDWARE	MEL-HH-1690-EO-HSEC-HEX 24 VDC	626	FAL
1	EA	ELEC PANIC HARDWARE	MEL-HH-1692-NL-OP-169CA-HSEC-HEX 24 VDC	626	FAL
1	EA	RIM CYLINDER	951	626	FAL
2	EA	90 DEG OFFSET PULL	8190EZHD-2	630-316	IVE
2	EA	SURFACE CLOSER	SC71A SS	689	FAL
2	EA	MOUNTING PLATE AS REQ'D	SC70-18/18PA	689	FAL
1	EA	FACIAL RECOGNITION READER	BY SYSTEM INTEGRATOR		
2	EA	DOOR CONTACT	BY SYSTEM INTEGRATOR		BYO
1	EA	MOTION SENSOR	BY SYSTEM INTEGRATOR	BLK	SCE
1	EA	POWER SUPPLY	PS914 900-2RS 120/240 VAC		VON
1		-	BALANCE OF HARDWARE BY DOOR SUPPLIER		

DOORS NORMALLY CLOSED AND LOCKED. DETECTING FACE ON FACIAL RECOGNITION READER UNLOCKS THE DOOR. FREE EGRESS AT ALL TIMES. UPON LOSS OF POWER DOORS ARE CLOSED AND SECURE SIDE IS LOCKED.

HARDWARE GROUP NO. 02

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
1	EA	CONT. HINGE	112XY EPT	628	IVE
1	EA	POWER TRANSFER	EPT10	689	VON
1	EA	ELEC PANIC HARDWARE	MEL-HH-1692-NL-OP-169CA-HSEC-HEX 24 VDC	626	FAL
1	EA	RIM CYLINDER	951	626	FAL
1	EA	90 DEG OFFSET PULL	8190EZHD-2	630-316	IVE
1	EA	SURFACE CLOSER	SC71A SS	689	FAL
1	EA	MOUNTING PLATE AS REQ'D	SC70-18/18PA	689	FAL
1	EA	CARD READER	BY SYSTEM INTEGRATOR		BYO
1	EA	DOOR CONTACT	BY SYSTEM INTEGRATOR		BYO
1	EA	MOTION SENSOR	BY SYSTEM INTEGRATOR	BLK	SCE
1	EA	POWER SUPPLY	PS914 900-2RS 120/240 VAC		VON
1		-	BALANCE OF HARDWARE BY DOOR SUPPLIER		

DOORS NORMALLY CLOSED AND LOCKED. PRESENTATION OF VALID CREDENTIAL UNLOCKS THE DOOR. FREE EGRESS AT ALL TIMES. UPON LOSS OF POWER DOORS ARE CLOSED AND SECURE SIDE IS LOCKED.

HARDWARE GROUP NO. 03

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	POWER TRANSFER	EPT10 CON	689	VON
1	EA	EU STOREROOM LOCK	T881P6 DAN CON 12/24 VDC	626	FAL
1	EA	SURFACE CLOSER	SC81A SS	689	FAL
1	EA	MOUNTING PLATE AS REQ'D	SC80A-18/18PA	689	FAL
1	EA	WIRE HARNESS	CON-LAR		SCH
1	EA	WIRE HARNESS	CON-6W		SCH
1	EA	FACIAL RECOGNITION READER	BY SYSTEM INTEGRATOR		
1	EA	DOOR CONTACT	BY SYSTEM INTEGRATOR		BYO
1	EA	MOTION SENSOR	BY SYSTEM INTEGRATOR	BLK	SCE
1	EA	POWER SUPPLY	BY SYSTEM INTEGRATOR	628	DRM
1		-	BALANCE OF HARDWARE BY DOOR SUPPLIER		

DETECTING FACE ON FACIAL RECOGNITION READER MOMENTARILY UNLOCKS LOCKSET. FAIL SECURE LOCK TIED INTO FIRE ALARM SYSTEM.

HARDWARE GROUP NO. 04

Provide each PR door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
2	EA	PIVOT	WELD ON PIVOTS PROVIDED X TGP	630	TGP
1	EA	FIRE EXIT HARDWARE	3547A-EO-F X TGP	626	VON
1	EA	FIRE EXIT HARDWARE	3547A-L-BE-F-06 X TGP	626	VON
2	EA	SURFACE CLOSER	4040XP SCUSH X TGP	689	LCN
2	EA	PA MOUNTING PLATE AS REQ'D	4040XP-18/18PA X TGP	689	LCN
1		-	BALANCE OF HARDWARE BY DOOR SUPPLIER		

HARDWARE GROUP NO. 05

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	ENTRY / OFFICE LOCK	T511P6 DAN	626	FAL
1	EA	WALL OR FLOOR STOP AS REQ'D	WS407/FS436 AS REQ'D	626	IVE
1	EA	-	BALANCE OF HARDWARE BY DOOR SUPPLIER		

HARDWARE GROUP NO. 06

Provide each BF door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
1		BY BI-FOLD SYSTEM MFR	ALL HARDWARE		

HARDWARE GROUP NO. 07

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	PASSAGE SET	T101 DAN	626	FAL
1	EA	WALL OR FLOOR STOP AS REQ'D	WS407/FS436 AS REQ'D	626	IVE
1		-	BALANCE OF HARDWARE BY DOOR SUPPLIER		

HARDWARE GROUP NO. 08

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
1	EA	CONT. HINGE	112XY EPT	628	IVE
1	EA	POWER TRANSFER	EPT10	689	VON
1	EA	ELEC PANIC HARDWARE	FSE-HH-25-R-L-DANE-299F 24 VDC	626	FAL
1	EA	MORTISE CYLINDER	986	626	FAL
1	EA	SURFACE CLOSER	SC71A SS	689	FAL
1	EA	RAIN DRIP	142AA	AA	ZER
1	EA	GASKETING	188SBK PSA	BK	ZER
1	EA	DOOR SWEEP	328AA	AA	ZER
1	EA	THRESHOLD	65A	A	ZER
1	EA	CARD READER	BY SYSTEM INTEGRATOR		BYO
1	EA	DOOR CONTACT	BY SYSTEM INTEGRATOR		BYO
1	EA	MOTION SENSOR	BY SYSTEM INTEGRATOR	BLK	SCE
1	EA	POWER SUPPLY	BY SYSTEM INTEGRATOR	628	DRM

DOOR NORMALLY CLOSED AND LOCKED. PRESENTATION OF VALID CREDENTIAL UNLOCKS DOOR. FREE EGRESS AT ALL TIMES. UPON LOSS OF POWER DOOR IS CLOSED AND SECURE SIDE IS LOCKED.

HARDWARE GROUP NO. 09

Provide each PR door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
8	EA	HINGE	5BB1 4.5 X 4.5 NRP	630	IVE
1	EA	PANIC HARDWARE	LD-HH-25-V-EO-SNB	626	FAL
1	EA	PANIC HARDWARE	LD-HH-25-V-NL-SNB	626	FAL
1	EA	MORTISE CYLINDER	986	626	FAL
2	EA	SURFACE CLOSER	SC71A SS	689	FAL
2	EA	KICK PLATE	8400 10" X 1" LDW B-CS	630	IVE
1	EA	RAIN DRIP	142AA	AA	ZER
1	EA	GASKETING	188SBK PSA	BK	ZER
2	EA	DOOR SWEEP	328AA	AA	ZER
1	EA	THRESHOLD	65A	A	ZER

HARDWARE GROUP NO. 10

Provide each PR door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
8	EA	HINGE	5BB1 4.5 X 4.5 NRP	630	IVE
2	EA	SURFACE BOLT	SB360 12" T	604	IVE
1	EA	STOREROOM LOCK	T581P6 DAN	626	FAL
2	EA	SURFACE CLOSER	SC71A SS	689	FAL
2	EA	KICK PLATE	8400 10" X 1" LDW B-CS	630	IVE
1	EA	RAIN DRIP	142AA	AA	ZER
1	EA	GASKETING	188SBK PSA	BK	ZER
2	EA	DOOR SWEEP	328AA	AA	ZER
1	EA	THRESHOLD	65A	A	ZER

ASTRAGAL BY DOOR MANUFACTURER.

HARDWARE GROUP NO. 11

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
4	EA	HINGE	5BB1 4.5 X 4.5 NRP	630	IVE
1	EA	STOREROOM LOCK	T581P6 DAN	626	FAL
1	EA	SURFACE CLOSER	SC71A SS	689	FAL
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	RAIN DRIP	142AA	AA	ZER
1	EA	GASKETING	188SBK PSA	BK	ZER
1	EA	DOOR SWEEP	328AA	AA	ZER
1	EA	THRESHOLD	65A	A	ZER

DOOR NORMALLY CLOSED AND LOCKED. PRESENTATION OF VALID CREDENTIAL UNLOCKS DOOR. FREE EGRESS AT ALL TIMES. UPON LOSS OF POWER DOOR IS CLOSED AND SECURE SIDE IS LOCKED.

HARDWARE GROUP NO. 12

Provide each PR door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
8	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	POWER TRANSFER	EPT10 CON	689	VON
1	EA	CONST LATCHING BOLT	FB51P	630	IVE
1	EA	DUST PROOF STRIKE	DP2	626	IVE
1	EA	EU STOREROOM LOCK	T881P6 DAN CON 12/24 VDC	626	FAL
1	EA	COORDINATOR	COR X FL	628	IVE
2	EA	MOUNTING BRACKET	MB1/MB2 AS REQUIRED	689	IVE
2	EA	OH STOP	450S	652	GLY
2	EA	SURFACE CLOSER	SC81A RW/PA	689	FAL
2	EA	DOOR SILENCER	SR64/SR65 AS REQ'D	GRY	IVE
2	EA	WIRE HARNESS	CON-LAR		SCH
2	EA	WIRE HARNESS	CON-6W		SCH
1	EA	CARD READER	BY SYSTEM INTEGRATOR		BYO
2	EA	DOOR CONTACT	BY SYSTEM INTEGRATOR		BYO
1	EA	MOTION SENSOR	BY SYSTEM INTEGRATOR	BLK	SCE
1	EA	POWER SUPPLY	BY SYSTEM INTEGRATOR	628	DRM

DOORS NORMALLY CLOSED AND LOCKED. PRESENTATION OF VALID CREDENTIAL UNLOCKS ACTIVE LEAF. FREE EGRESS AT ALL TIMES. UPON LOSS OF POWER DOORS ARE CLOSED AND LOCKED.

HARDWARE GROUP NO. 13

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	POWER TRANSFER	EPT10 CON	689	VON
1	EA	EU STOREROOM LOCK	T881P6 DAN CON 12/24 VDC	626	FAL
1	EA	SURFACE CLOSER	SC81A RW/PA	689	FAL
1	EA	WALL OR FLOOR STOP AS REQ'D	WS407/FS436 AS REQ'D	626	IVE
1	EA	DOOR SILENCER	SR64/SR65 AS REQ'D	GRY	IVE
1	EA	WIRE HARNESS	CON-LAR		SCH
1	EA	WIRE HARNESS	CON-6W		SCH
1	EA	CARD READER	BY SYSTEM INTEGRATOR		BYO
1	EA	DOOR CONTACT	BY SYSTEM INTEGRATOR		BYO
1	EA	MOTION SENSOR	BY SYSTEM INTEGRATOR	BLK	SCE
1	EA	POWER SUPPLY	BY SYSTEM INTEGRATOR	628	DRM

DOORS NORMALLY CLOSED AND LOCKED. PRESENTATION OF VALID CREDENTIAL UNLOCKS ACTIVE LEAF. FREE EGRESS AT ALL TIMES. UPON LOSS OF POWER DOORS ARE CLOSED AND LOCKED.

HARDWARE GROUP NO. 14

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	POWER TRANSFER	EPT10	689	VON
1	EA	ELEC PANIC HARDWARE	FSE-25-R-L-DANE 24 VDC	626	FAL
1	EA	MORTISE CYLINDER	986	626	FAL
1	EA	SURFACE CLOSER	SC81A RW/PA	689	FAL
1	EA	WALL OR FLOOR STOP AS REQ'D	WS407/FS436 AS REQ'D	626	IVE
3	EA	DOOR SILENCER	SR64/SR65 AS REQ'D	GRY	IVE
1	EA	FACIAL RECOGNITION READER	BY SYSTEM INTEGRATOR		
1	EA	DOOR CONTACT	BY SYSTEM INTEGRATOR		BYO
1	EA	MOTION SENSOR	BY SYSTEM INTEGRATOR	BLK	SCE
1	EA	POWER SUPPLY	BY SYSTEM INTEGRATOR	628	DRM

DOOR NORMALLY CLOSED AND LOCKED. PRESENTATION OF VALID CREDENTIAL UNLOCKS DOOR. FREE EGRESS AT ALL TIMES. UPON LOSS OF POWER DOOR IS CLOSED AND SECURE SIDE IS LOCKED.

HARDWARE GROUP NO. 15

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	POWER TRANSFER	EPT10 CON	689	VON
1	EA	EU STOREROOM LOCK	T881P6 DAN CON 12/24 VDC	626	FAL
1	EA	SURFACE CLOSER	SC81A RW/PA	689	FAL
1	EA	WALL OR FLOOR STOP AS REQ'D	WS407/FS436 AS REQ'D	626	IVE
3	EA	DOOR SILENCER	SR64/SR65 AS REQ'D	GRY	IVE
1	EA	WIRE HARNESS	CON-LAR		SCH
1	EA	WIRE HARNESS	CON-6W		SCH
1	EA	CARD READER	BY SYSTEM INTEGRATOR		BYO
1	EA	DOOR CONTACT	BY SYSTEM INTEGRATOR		BYO
1	EA	MOTION SENSOR	BY SYSTEM INTEGRATOR	BLK	SCE
1	EA	POWER SUPPLY	BY SYSTEM INTEGRATOR	628	DRM

DOOR NORMALLY CLOSED AND LOCKED. PRESENTATION OF VALID CREDENTIAL UNLOCKS DOOR. FREE EGRESS AT ALL TIMES. UPON LOSS OF POWER DOOR IS CLOSED AND SECURE SIDE IS LOCKED.

HARDWARE GROUP NO. 16

Provide each PR door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
6	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	FIRE EXIT HARDWARE	F-25-V-EO-LBR	626	FAL
1	EA	FIRE EXIT HARDWARE	F-25-V-L-NL-LBR-DANE	626	FAL
1	EA	MORTISE CYLINDER	987	626	FAL
2	EA	SURFACE CLOSER	SC81A RW/PA	689	FAL
2	EA	KICK PLATE	8400 10" X 1" LDW B-CS	630	IVE
2	EA	WALL OR FLOOR STOP AS REQ'D	WS407/FS436 AS REQ'D	626	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER

FLAT ASTRAGAL BY DOOR MANUFACTURER

DOORS NORMALLY CLOSED AND LOCKED. PRESENTATION OF VALID CREDENTIAL UNLOCKS ACTIVE LEAF. FREE EGRESS AT ALL TIMES. UPON LOSS OF POWER DOORS ARE CLOSED AND LOCKED.

HARDWARE GROUP NO. 17

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	FIRE EXIT HARDWARE	F-25-R-L-BE-DANE	626	FAL
1	EA	SURFACE CLOSER	SC81A RW/PA	689	FAL
1	EA	WALL OR FLOOR STOP AS REQ'D	WS407/FS436 AS REQ'D	626	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER

HARDWARE GROUP NO. 18

Provide each PR door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
6	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
2	EA	MANUAL FLUSH BOLT	FB458	626	IVE
1	EA	DUST PROOF STRIKE	DP2	626	IVE
1	EA	STOREROOM LOCK	T581P6 DAN	626	FAL
2	EA	SURFACE CLOSER	SC81A SS	689	FAL
2	EA	DOOR SILENCER	SR64/SR65 AS REQ'D	GRY	IVE

HARDWARE GROUP NO. 19

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	STOREROOM LOCK	T581P6 DAN	626	FAL
1	EA	WALL OR FLOOR STOP AS REQ'D	WS407/FS436 AS REQ'D	626	IVE
3	EA	DOOR SILENCER	SR64/SR65 AS REQ'D	GRY	IVE

HARDWARE GROUP NO. 20

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	STOREROOM LOCK	T581P6 DAN	626	FAL
1	EA	SURFACE CLOSER	SC81A RW/PA	689	FAL
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	WALL OR FLOOR STOP AS REQ'D	WS407/FS436 AS REQ'D	626	IVE
3	EA	DOOR SILENCER	SR64/SR65 AS REQ'D	GRY	IVE

HARDWARE GROUP NO. 21

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	STOREROOM LOCK	T581P6 DAN	626	FAL
1	EA	SURFACE CLOSER	SC81A RW/PA	689	FAL
1	EA	WALL OR FLOOR STOP AS REQ'D	WS407/FS436 AS REQ'D	626	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER

HARDWARE GROUP NO. 22

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	STOREROOM LOCK	T581P6 DAN	626	FAL
1	EA	SURFACE CLOSER	SC81A SS	689	FAL
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER

HARDWARE GROUP NO. 23

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	PASSAGE SET	T101 DAN	626	FAL
1	EA	WALL OR FLOOR STOP AS REQ'D	WS407/FS436 AS REQ'D	626	IVE
3	EA	DOOR SILENCER	SR64/SR65 AS REQ'D	GRY	IVE

HARDWARE GROUP NO. 24

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1HW 4.5 X 4.5	652	IVE
1	EA	PUSH PLATE	8200 4" X 16"	630AM	IVE
1	EA	PULL PLATE	8303 10" 4" X 16"	626AM	IVE
1	EA	SURFACE CLOSER	SC81A RW/PA	689	FAL
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	WALL OR FLOOR STOP AS REQ'D	WS407/FS436 AS REQ'D	626	IVE
3	EA	DOOR SILENCER	SR64/SR65 AS REQ'D	GRY	IVE

HARDWARE GROUP NO. 25

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	PRIVACY LOCK W/ OUTSIDE INDICATOR	ND40S RHO 13-248 626AM OS-OCC	626AM	SCH
1	EA	SURFACE CLOSER	SC81A RW/PA	689	FAL
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	WALL OR FLOOR STOP AS REQ'D	WS407/FS436 AS REQ'D	626	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER

HARDWARE GROUP NO. 26

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	PASSAGE SET	ND10S RHO	626AM	SCH
1	EA	SURFACE CLOSER	SC81A RW/PA	689	FAL
1	EA	WALL OR FLOOR STOP AS REQ'D	WS407/FS436 AS REQ'D	626	IVE
3	EA	DOOR SILENCER	SR64/SR65 AS REQ'D	GRY	IVE

END OF SECTION 08 71 00

SECTION 08 81 00
GLASS AND GLAZING

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes:
 - 1. Impact resistant insulated glass and glazing required for aluminum framed entrances and storefronts.
 - 2. Refer to Plans for locations and types of glass and glazing required.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00:
 - 1. Refer to "PART 2 – PRODUCTS" for all Buy America Build America Act (BABA) Requirements
- B. JOINT SEALANTS: Section 07 92 00.
- C. HOLLOW METAL DOORS AND FRAMES: Section 08 11 13
- D. ALUMINUM-FRAMED ENTRANCES AND STOREFRONTS: Section 08 41 13.
- E. LC PRIVACY GLASS – Section 08 88 36.

1.03 DEFINITIONS

- A. "Glass" includes both primary and fabricated glass products as described in GANA "Glazing Manual."
- B. "Glazing" includes glass installation and materials used to install glass.

1.04 PERFORMANCE CRITERIA

- A. Provide glass and glazing that has been produced, fabricated, and installed to withstand normal impact loading (where applicable), without failure of sealants or gaskets to remain airtight, deterioration of glass and glazing materials, and other defects in the work.

1.05 QUALITY ASSURANCE

- A. Single Source Responsibility: Provide materials obtained from one source for each type of glass and glazing product indicated.
- B. Source Quality Control: All glass shall bear the manufacturer's identifying label.
- C. Safety Glazing Standard:

1. Where safety glass is indicated or required by authorities having jurisdiction, provide type of products indicated which comply with ANSI Z 97.1, and testing requirements of 16 CFR Part 1201 for category II materials.
 2. Comply with Florida Statutes - Chapter 553, Part III, Safety Performance Specifications and Methods of Test for Safety Glazing Used in Buildings.
 3. Subject to compliance with requirements, provide safety glass permanently marked with certification label of Safety Glass Certification Council (SGCC) or other certification agency acceptable to authorities having jurisdiction.
- D. Reference Standards: Comply with provisions of the following, unless otherwise indicated or specified:
1. American Architectural Manufacturers Association (AAMA):
 - a. AAMA Voluntary Specifications and Test Methods for Sealants.
 2. American National Standards Institute (ANSI):
 - a. ANSI Z 97.1 Glazing Materials Used in Buildings - Safety Performance Specifications and Methods of Test.
 3. American Society for Testing and Materials (ASTM):
 - a. ASTM C 1036 Standard Specification for Flat Glass.
 - b. ASTM C 1048 Standard Specification for Heat-Treated Flat Glass - Kind HS, Kind FT Coated and Uncoated Glass.

1.06 SUBMITTALS

- A. Product Data: Submit manufacturer's technical data for each glazing material and fabricated glass product required, including installation and maintenance instructions.
- B. Samples: Submit three (3) - 12 inch square samples of each type of glass scheduled for installation, and three (3) - 12 inch lengths of each type of gasket employed.

1.07 DELIVERY, STORAGE AND HANDLING

- A. Product Delivery: Deliver glass to job site in suitable containers that will provide protection from weather and breakage.
- B. Storage and Handling: Comply with manufacturer's published directions and as required to prevent edge damage to glass and damage to glass and glazing materials from effects of moisture including condensation, of temperature changes, of direct exposure to sun, and from other causes; and keep glass free from contamination by materials capable of staining material.

1.08 PROJECT CONDITIONS

- A. Measurements: Sizes for glass shall be measured from the actual installed openings, frames, and doors.
- B. Environmental Requirements: Perform glazing when ambient temperature is above 40 degrees F., and on dry surfaces only.
- C. Sequence, Scheduling: Schedule glass deliveries to coincide with glazing schedules.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Products: Subject to compliance with requirements, provide glass products by one of the following manufacturers:
 - 1. Interpane Glass Company.
 - 2. Guardian Industries.
 - 3. PPG Industries, Inc.
 - 4. Pilkington Libbey-Owens-Ford.
 - 5. Viracon.

2.02 2.02 GLASS MATERIALS

- A. Glass Standards:
 - 1. Primary Glass Standard: Provide primary glass which complies with ASTM C 1036 requirements, including those indicated by reference to type, class, quality, and, if applicable; form, finish, mesh, and pattern.
 - 2. Heat-Treated Glass Standard: Provide heat-treated glass which complies with ASTM C 1048 requirements, including those indicated by reference to kind, condition, type, quality, and, if applicable; form, finish, and pattern.
- B. Glass Types:
 - 1. Gl-1 1 5/16" Clear, Insulated, Laminated Impact Glazing
 - 2. Gl-1a 1 5/16" Etched, Insulated, Laminated Impact Glazing
 - 3. Gl-2 9/16" Clear, Laminated Impact Glazing
 - 4. Gl-2a 9/16" Etched, Laminated Impact Glazing
 - 5. Gl-3 1/4" Clear, Tempered Impact Glazing

6. GI-4 9/16" 3/4 Hr Fire Rated Laminated Impact Glazing
 7. GI-5 5/16" Clear Standard Switchable Glass
- C. Laminated Impact Resistant Glass: Provide impact resistant laminated glass composed of the following:
1. Outboard Glass Layer: Low-E heat-treated coated clear or etched (as indicated)
 2. PVB/Polyester Intermediate Laminate Layer: .043 mil thick polyvinyl butyral (PVB) layer laminated to a .007 mil thick polyester layer, with an abrasion-resistant polysiloxane coating applied over the PVB layer of the film composite. The polyester layer of the film composite adhered to glass surface.
 3. Inboard Glass Layer: Clear float heat-treated glass
- D. Insulating Glass Unit Assemblies:
1. Exterior Lite
 2. Air Space
 3. Interior Lite: Laminated Impact Resistant Glass (2.2, Paragraph C., above).

2.03 GLAZING MATERIALS

- A. General: Comply with recommendations of sealant and glass manufacturers for selection of glazing materials which have performance characteristics suitable for applications indicated and conditions at time of installation.
1. Select glazing materials with proven compatibility with surfaces contacted in the installation and under service conditions indicated, as demonstrated by testing and field experience.
- B. Glazing Sealants:
1. Silicone Glazing Sealant: Single component elastomeric silicone sealant complying with ASTM C 920, Type S, Grade NS, Class 25.
 2. Colors: Provide color of exposed sealants as selected by Engineer from manufacturer's standard colors.
 3. Products: Provide one of the following glazing sealants:
 - a. "Chem-Calk 1000"; Bostik.
 - b. "Dow Corning 790"; Dow Corning Corp.
 - c. "Silglaze 2800"; GE Silicones.
 - d. "Silpruf"; GE Silicones.

- e. "864"; Pecora Corp.
 - f. "Omniseal"; Sonneborn Building Products Div. of Chemrex, Inc.
- C. Preformed Butyl-Polyisobutylene Glazing Tape:
- 1. Blend of butyl polyisobutylene rubber with a solid content of 100 percent, in extruded tape form, complying with AAMA 807.3, packaged on rolls with a release paper on side, with or without continuous spacer rod as recommended by manufacturers of tapes and glass for application indicated.
 - 2. Products: Provide one of the following glazing tapes:
 - a. "PTI 606"; H.B. Fuller Company.
 - b. "PTI 303"; H.B. Fuller Company.
 - c. "Tremco 440 Tape"; Tremco, Inc.
 - d. "MBT-35"; Tremco, Inc.
 - e. "Extru-Seal"; Pecora Corp.
- D. Glazing Gaskets:
- 1. Dense Elastomeric Compression Seal Gaskets: Molded or extruded neoprene or EPDM gaskets of profile and hardness required to maintain watertight seal; complying with ASTM C 864, Option 1.
 - 2. Cellular Elastomeric Preformed Gaskets: Extruded or molded closed cell, integral-skinned neoprene of profile and hardness required to maintain watertight seal; complying with ASTM C 509, Type II; black.
 - 3. Products: Provide gaskets by one of the following manufacturers:
 - a. D.S. Brown Co.
 - b. Maloney Precision Products Co.
 - c. Tremco Inc.
- E. Setting Blocks: Neoprene, EPDM, or silicone blocks are required for compatibility with glazing sealants, 80 to 90 Shore A durometer hardness.
- F. Spacers: Neoprene, EPDM or silicone blocks, or continuous extrusions, as required for compatibility with glazing sealant, of size, shape, and hardness recommended by glass and sealant manufacturers for application indicated.
- G. Edge Blocks: Neoprene, EPDM or silicone blocks as required for compatibility with glazing sealant, of size and hardness required to limit lateral movement (side-walking) of glass.

H. Cleaners, Primers, and Sealers: Type recommended by sealant or gasket manufacturer.

2.04 FABRICATION

- A. Sizes: Fabricate glass and glazing material to sizes required for glazing openings indicated, with edge clearances and tolerances complying with recommendations of glass manufacturer. Provide thicknesses indicated or, if not otherwise indicated, as recommended by glass manufacturer for application indicated.
- B. Tong Marks: Provide tempered glass produced by manufacturer's special process which eliminates tong marks, for locations and installation condition where tong marks would otherwise be exposed. No exposed tong marks shall be permitted.

PART 3 - PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine framing glazing, with Installer present, for compliance with the following:
- B. Manufacturing and installation tolerances, including those for size, squareness, and offsets at corners.
- C. Presence and functioning of weep system.
- D. Minimum required face or edge clearances.
- E. Effective sealing between joints of glass framing members.
- F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings not firmly bonded to substrates.

3.03 INSTALLATION

- A. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.
- B. Where "Heat Treated" glass is noted, it shall be Heat Strengthened except where "Fully Tempered" is required at doors, adjacent sidelights, and other areas as required by Florida Building Code.
- C. Glazing channel dimensions, as indicated on Drawings, provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances. Adjust as required by Project conditions during installation.
- D. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass is glass with edge

damage or other imperfections that, when installed, could weaken glass and impair performance and appearance.

- E. Set glass lites in each series with uniform pattern, draw, bow, and similar characteristics.

3.04 CLEANING AND PROTECTION

- A. Protect exterior glass from damage immediately after installation by attaching crossed streamers to framing held away from glass. Do not apply markers to glass surface. Remove nonpermanent labels, and clean surfaces.
- B. Protect glass from contact with contaminating substances resulting from construction operations, including weld splatter. If, despite such protection, contaminating substances do come into contact with glass, remove substances immediately as recommended by glass manufacturer.
- C. Remove and replace glass that is broken, chipped, cracked, or abraded or that is damaged from natural causes, accidents, and vandalism, during construction period.

END OF SECTION 08 81 00

SECTION 08 88 36
LC PRIVACY GLASS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes switchable privacy glass, glazing accessories and supplementary items necessary to complete the work required for their installation.

1.02 RELATED WORK:

- A. SUMMARY OF WORK: Section 01 11 00:
 - 1. Refer to "PART 2 – PRODUCTS" for all Buy America Build America Act (BABA) Requirements
- B. JOINT SEALANTS: Section 07 92 00.
- C. HOLLOW METAL DOORS AND FRAMES: Section 08 11 13
- D. ALUMINUM-FRAMED ENTRANCES AND STOREFRONTS: Section 08 41 13.
- E. Division 26: Electrical

1.03 REFERENCE STANDARDS

- A. ASTM C 1036 - Standard Specification for Flat Glass.
- B. ASTM C 1048 - Standard Specification for Heat-Treated Flat Glass--Kind HS, Kind FT Coated and Uncoated Glass.
- C. ASTM C 1172 - Standard Specification for Laminated Architectural Flat Glass.
- D. CPSC 16CFR-1201 - Safety Standard for Architectural Glazing Materials.
- E. GANA Glazing Manual.
- F. GANA Laminated Glazing Reference Manual
- G. GANA Glass Information Bulletins

1.04 DEFINITIONS

- A. Connection Nipple: Fitting attached to the edge of the glass that wires pass through to provide strain relief for wires
- B. Lay Flat Wiring Bar: Alternate to Connection Nipple; Used to run wires parallel with the edge of the glass
- C. Greenfield: A metallic flexible conduit used to shield the wires coming from the glass

- D. Busbar: Copper foil tape which supplies power to switchable liquid crystal film
- E. Frosted State: The default state of switchable privacy glass; no power running to the glass
- F. Transparent State: The powered state of the glass, with its highest level of clarity.
- G. Off-Axis: When the line of sight to the glass is at an angle; not straight on.

1.05 SUBMITTALS

- A. Comply with Division 01 Section "Submittal Procedures."
- B. Product Data: Submit manufacturer's product data, including performance characteristics and installation instructions.
- C. Shop Drawings: Submit manufacturer's or fabricator's shop drawings, including plans, elevations, sections, and details, indicating glass dimensions, tolerances, types, thicknesses, and coatings.
- D. Samples: Submit 8" x 11" functioning manufacturer's samples of each type, thickness, and coating.
- E. Warranty: Submit manufacturer's standard warranty for switchable privacy glass units.

1.06 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Minimum of 5 years' experience manufacturing switchable glass.
- B. Installer's Qualifications:
 - 1. Minimum of 5 years' experience in installing and handling laminated glass meeting ASTM C 1172 and CPSC 16CFR-1201.
- C. Mock-Ups:
 - 1. Comply with Division 01 Section "Quality Control."
 - 2. Obtain acceptance of mock-ups by Architect before proceeding with work.
 - 3. Mock-ups will be considered a chargeable item and are not considered part of the regular job costs.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Delivery:
 - 1. Deliver glass to site in accordance with manufacturer's instructions.
 - 2. Deliver glass in manufacturers or fabricator's original containers and packaging with labels clearly identifying product name and manufacturer.

B. Storage:

1. Store glass in accordance with manufacturer's instructions.
2. Store glass in clean, dry area indoors.
3. Protect from exposure to direct sunlight and freezing temperatures.
4. Apply temporary coverings loosely to allow adequate ventilation.
5. Protect from contact with corrosive chemicals.
6. Avoid placement of glass edge on concrete, metal, and other hard objects.
7. Rest glass on clean, cushioned pads at 1/4-points.

C. Handling:

1. Handle glass in accordance with manufacturer's instructions.
2. Protect glass from damage during handling and installation.
3. Do not slide lites of glass against one another.
4. Do not use sharp objects near unprotected glass.

1.08 WARRANTY

A. Manufacturer's Warranty on Switchable Privacy Glass: Manufacturer's standard form in which Switchable Privacy Glass manufacturer agrees to replace Switchable Privacy Glass units that fail within specified warranty period.

1. Warranty Period on the function of the Switchable Privacy Glass Unit: 5 years from date of receipt by purchaser
 - a. Defects in material or workmanship causing material obstruction of vision as a result of electrical failure of the switchable film.
 - b. Defects in material or workmanship causing the switchable film to no longer switch from frosted to translucent.
 - c. Must provide a written copy of Manufacturer's 5-year Warranty at time of purchase.
2. Warranty Period on the lamination of Switchable Privacy Glass: 5 years from date of shipment
 - a. Deterioration of laminated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning

laminated glass contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated-glass standard of ASTM.

- b. Must provide a written copy of Manufacturer's 5-year Warranty at time of purchase.

PART 2 - PRODUCTS

2.01 MANUFACTURER

- A. Basis of design: LC Privacy Glass by Innovative Glass Corp.

2.02 FABRICATORS

- A. Sealed Insulating Glass Units, Laminated Glass Units, Heat-Strengthened Glass, Tempered Glass, and Spandrel Glass:
- B. Acceptable Fabricators: All must be certified by glass manufacturer.

2.03 LAMINATED SWITCHABLE PRIVACY GLASS MATERIALS

- A. Switchable Privacy film: Approx. [0.012 inch] [0.40 mm] thick film
- B. Interlayers: .060 total interlayer thickness typical
- C. Glass Components:
 - 1. Annealed clear OR low iron glass: Clear, transparent, flat, annealed, float glass, conforming to ASTM C1036, Type I, Class 1, Quality q3.
 - 2. Heat strengthened glass: Provide heat strengthened, annealed glass components where indicated or required to adequately support imposed loads, to allow for large glass size, and resist anticipated thermal stresses in accordance with ASTM C1048, Kind HS.
 - 3. Fully tempered glass:
 - a. Provide heat tempered, annealed glass components where required to adequately resist loading conditions, size of units, and anticipated thermal stresses in accordance with ASTM C1048, Kind FT.
 - b. Fully tempered glass shall meet requirements of ANSI Z97.1 and CPSC 16 CFR to qualify as safety glass.
 - 4. Plastic glazing: Transparent, flat, impact resistant polycarbonate plastic sheet with abrasion resistant coating.
 - 5. Standard Switchable Glass thickness make-ups:
 - a. 5/16" (8mm) = 1/8" Glass / LC Interlayer / 1/8" Glass

6. Edge treatments:
 - a. Ground Verticals – Use this for butt glazed glass panels where no vertical edges are exposed.
 - b. Polished Verticals – Use this for butt glazed panels where vertical edges will be exposed. All glass doors will also use this option.
 - c. Edge Seal – Use this when panels are captured on all sides.
7. Bus bars used to terminate switchable film will be made of copper foil conductive tape and will be positioned on the top of the panel unless otherwise specified.

2.04 ELECTRICAL REQUIREMENTS

- A. Operating Voltage: 48 – 65 VAC
- B. Operating Current: .020 Amps (20mA per SqFt.)
- C. Power consumption: Less than 1 watt per sq ft of privacy glass.
- D. One 65vac transformer required per independently controlled zone
- E. Bus bars will be visible for 5/8” in from the edge of the glass and installer should account for adequate frame coverage to hide them during installation.
- F. Panels shall be fabricated with 2-Conductor 18Ga Wires; 20ft long through Connection Nipple or Lay Flat Wiring Bar.
- G. Wire leads from the glass should be shielded if required by local building codes.
- H. 120VAC receptacle BY OTHERS required to power the transformer for the glass. Refer to wiring schematic for further details.
- I. 18ga wire leads from the glass shall be spliced together with input leads on the transformer.
- J. All wiring to be completed in accordance with manufacturer’s wiring instructions.
- K. Glass and transformers may be integrated into building automation system for automated and remote control. System must have prior approval of glass manufacturer.
- L. Transformer must come with an option for an RF Remote Control.

2.05 PERFORMANCE

- A. Visible haze is expected when Switchable Privacy Glass is in the transparent state. Noticeable haze will be 3-8% depending on substrates used in the glass make-up. Haze will be more noticeable when glass is viewed off-axis (at an angle) and less noticeable when viewed straight on.
- B. Operating Temperature Range (installed environment):

1. Range = 14°F to +122°F
- C. UV Light Blocking:
 1. On/Off = 99%
- D. Parallel Light Transmittance:
 1. T (On) = > 75%
 2. T (Off) = < 2%
- E. Visible Light Transmittance:
 1. T (On) = 88% to 91%
 2. T (Off) = < 50%
- F. Switchable Glass must be UL Listed
- G. Switching Speed ON/OFF:
 1. <15ms/50ms

2.06 SPECIAL APPLICATIONS

- A. Curved Glass: Switchable Privacy Glass can be made using curved glass. Please consult Innovative Representative for limitations.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine areas to receive glass. Notify Architect of conditions that would adversely affect installation. Do not proceed with installation until unsatisfactory conditions are corrected.

3.02 PREPARATION

- A. Verify glazing openings are correct size and within tolerance.
- B. Verify glazing channels, recesses, and weeps are clean and free of obstructions.

3.03 GLAZING

- A. Install glass in accordance with manufacturer's instructions, except where local codes or GANA Glazing Manual indicate more stringent requirements.
- B. Acceptable glazing silicones for field glazing into frames.
 1. Only DOW995 shall be used in any enclosed glazing pocket
 2. DOW1199 Silicone should be used to fill butt joints

3.04 FIELD QUALITY CONTROL

- A. Coated glass, when viewed from minimum of 10 feet, exhibiting slightly different hue or color not apparent in hand samples, will not be cause of rejection of glass units, as determined by Architect.
- B. Verify glass is free of chips, cracks, and other inclusions that could inhibit structural or aesthetic integrity PRIOR TO INSTALLATION.
- C. All glass panels to be electrically tested before and after installation.
- D. Glass shall be demonstrated to Owner after installation.

3.05 CLEANING

- A. Clean glass promptly after installation in accordance with manufacturer's instructions.
- B. Remove labels from glass surface.
- C. Do not use harsh cleaning materials or methods that would damage glass.
 - 1. Refer to the following GANA Glass Information Bulletins:
 - a. GANA 01-0300 - Proper Procedures for Cleaning Architectural Glass Products.
 - b. GANA TD-02-0402 - Heat-Treated Glass Surfaces Are Different.
 - c. Innovative Glass eGlass Cleaning Guide
- D. Do not use scrapers or other metal tools to clean glass.

3.06 PROTECTION

- A. Protect installed glass from damage during construction.
- B. Protect installed glass from contact with contaminating substances resulting from construction operations.
- C. Remove and replace glass which is broken, chipped, cracked, abraded, or damaged in other ways during construction period, including natural causes, accidents, and vandalism.

END OF SECTION

SECTION 08 91 19
FIXED LOUVERS

PART 1 - GENERAL

1.01 RELATED WORK

A. SUMMARY OF WORK: Section 01 11 00:

1. Refer to "PART 2 – PRODUCTS" for all Buy America Build America Act (BABA) Requirements

1.02 SUMMARY

- A. Furnish and install exterior fixed metal louvers as indicated on the Plans and specified herein.

1.03 QUALITY ASSURANCE

- A. Reference Standards: Comply with provisions of the following, unless otherwise indicated or specified:

1. American Architectural Manufacturers Association (AAMA):

- a. Referenced Standards.

2. Air Movement and Control Association (AMCA):

- a. Referenced Standards.

3. American Society for Testing and Materials (ASTM):

- a. Referenced Standards.

4. American Welding Society (AWS):

- a. Referenced Standards.

5. Steel Structures Painting Council (SSPC):

- a. Referenced Standards.

- B. Welding: Qualify procedures and personnel according to AWS D1.2 "Structural Welding Code."

1.04 PERFORMANCE REQUIREMENTS

- A. Approved Products: As applicable, products used herein shall comply with requirements of the Florida Product Approval System as required by Florida Statute 553.842 and Florida Administrative Code 9B-72.

- B. Structural Performance: Provide louvers capable of withstanding the effects of wind loads

and stresses within limits and under conditions indicated without permanent deformation of louver components, noise or metal fatigue caused by louver blade rattle or flutter, or permanent damage to fasteners and anchors. Wind pressures shall be considered to act on vertical projection of louvers.

1. Wind Loads: Determine loads based on pressures in compliance with the Florida Building Code, Latest Adopted Edition, as amended, for the geographical location of the Project.
- C. Provide louvers complying with performance requirements for louver types specified, as demonstrated by testing manufacturer's stock units identical to those provided, except for length and width, according to AMCA Standard 500-L.
- D. Provide louvers with AMCA Certified Ratings Seal evidencing that product complies with specified requirements.

1.05 SUBMITTALS

- A. Product Data:
 1. Submit manufacturer's specifications, certified test data, and installation instructions for required products, including finishes.
- B. Shop Drawings:
 1. Complete shop drawings shall be prepared for this work indicating the materials, sizes of members and units, construction and clearances required, and methods of securing to attachment substrates. Include instructions for installation of anchoring devices built into other work. As a minimum, fasteners must be equal to test assembly.
- C. Samples:
 1. Submit three (3) 6 inch square samples of each required finish. Prepare samples on metal of same gauge and alloy to be used in work.
- D. Warranty:
 1. Submit specimen copy of specified warranty.

1.06 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Deliver louver units in substantial, protective cartons and with protective masking over finished surfaces. Retain masking until completion of Project work, unless otherwise determined by the Contractor.
- B. Store louver units indoors and protected from any building contamination resulting from construction activities.
- C. Handle all units carefully to preclude damage to surface finishes. In the event of damage, immediately make all repairs, or replacements, as necessary to the approval of the Engineer and at no additional cost to the Owner.

1.07 PROJECT CONDITIONS

- A. Field Measurements: Take field measurements prior to preparation of shop drawings and fabrication to ensure proper fitting of work.
- B. Shop Assembly: Pre-assemble units in shop to greatest extent possible and disassemble as necessary for shipping and handling limitations. Clearly mark units for re-assembly and coordinated installation.
- C. Coordination: Coordinate field measurements and shop drawings with fabrication and shop assembly to minimize field adjustments, splicing, mechanical joints, and field assembly of units.

1.08 WARRANTY

- A. Special Finish Warranty: Provide manufacturer's standard twenty (20) year finish performance warranty.

PART 2 - PRODUCTS

2.01 MANUFACTURER

- A. Products: Provide products by one of the following manufacturers:
 - 1. Greenheck.
 - 2. The Airolite Company.
 - 3. Construction Specialties, Inc.
 - 4. Ruskin Company.
 - 5. Perspective Glass Company.

2.02 LOUVERS

- A. Standard profile, sightproof design, louvers, depth as indicated and assembled completely by welding. Blades and frame shall be 12 gauge (.081 inch) extruded aluminum, alloy 6063-T52, ASTM B 221.
 - 1. Basis of Design: Greenheck EVH-302D.
- B. Louvers shall bear AMCA Certified Ratings Seals for air performance and water penetration ratings and shall have received the State of Florida Notice of Approval meeting Florida Building Code requirements.

2.03 ACCESSORIES

- A. Fastenings: Use same material as items fastened. Provide types, gauges, and lengths to suit unit installation conditions. Use phillips flat-head machine screws for exposed fastenings, unless otherwise indicated and/or required.

- B. Screens: Provide for all louvers, and as follows:
 - 1. Bird Screening: Aluminum, 1/2 inch square mesh, 0,063 inch wire.
 - 2. Insect Screening: 18 - 14 mesh, 0.011 inch aluminum wire.
 - 3. Locate screens on inside face of louvers, unless otherwise indicated. Secure screens to louver frames with machine screws, located at each corner and spaced 12 inches on center. Screens shall be removable for maintenance and cleaning.
- C. Bituminous Coatings: Cold-applied asphalt mastic complying with SSPC-PS 12, compounded for 40-mil thickness per coat on surfaces of dissimilar metals.

2.04 METAL FINISHES

- A. High Performance Coating: Provide manufacturer's standard fluoropolymer 2-coat thermocured coating system composed of specially formulated inhibitive primer and fluoropolymer color top coat containing not less than 70 percent polyvinylidene fluoride resin by weight; comply with AAMA 2605.
 - 1. Color to be selected by Engineer.
 - 2. Products: Provide option of clear anodized factory finish or fluoropolymer coating systems containing one of the following resins:
 - a. "Hylar 5000"; Ausimont USA, Inc.
 - b. "Kynar 500"; Elf Atochem North America, Inc.

PART 3 - EXECUTION

3.01 INSPECTION

- A. Examine the areas and conditions under which the metal louvers are to be installed. Do not proceed with metal louver work until unsatisfactory conditions have been corrected.

3.02 FIELD MEASUREMENT

- A. Verify louver openings by field measurements, before fabrication and indicate measurements on shop drawings.

3.03 INSTALLATION

- A. Comply with manufacturer's published instructions and current recommendations for installation of metal louvers.
- B. All items under this heading shall be set in their correct locations as shown on the Plans and shall be level, square, plumb, and at proper elevations and in alignment with other work.
- C. Install all members with adequate provisions for settling, expanding, and contracting to

occur without bending louver blades. Firmly anchor all members, using all anchoring devices required to ensure positive attachment of the members. Set sill members in full bed of mastic.

- D. Use concealed anchorages wherever possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weathertight connection.
- E. Form tight joints with exposed connections accurately fitted together. Provide reveals and openings for sealants and joint fillers as indicated and/or required.
- F. Provide concealed gaskets, flashings, and joint fillers, and install as work progresses to make installations weathertight.
- G. Sealants at perimeter joints of units be applied under Section 07 92 00 – JOINT SEALANTS.

3.04 FINISH REPAIRS

- A. Repair finishes which are damaged by cutting, welding, soldering, and grinding operations that are required for fitting and jointing.
- B. Restore finishes so there is no evidence of corrective work. Return items that cannot be re-finished in field to shop; make required alterations; and re-finish entire unit, or provide new units at the direction of the Engineer.

END OF SECTION 08 91 19

SECTION 09 22 16
NON-STRUCTURAL COLD FORMED METAL FRAMING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. SUMMARY OF WORK: Section 01 11 00:
 - 1. Refer to "PART 2 – PRODUCTS" for all Buy America Build America Act (BABA) Requirements

1.02 SUMMARY

- A. This Section includes non-load-bearing steel framing members for the following applications:
 - 1. Interior framing systems (e.g., supports for partition walls, framed soffits, furring, etc.).
 - 2. Interior suspension systems (e.g., supports for ceilings, suspended soffits, etc.).
- B. Related Sections include the following:
 - 1. Division 7 Section "Thermal Insulation" for insulation installed with Z-shaped furring members.
 - 2. Division 9 Section "Portland Cement Plaster" for metal lath supported by non-load-bearing steel framing.

1.03 SUBMITTALS

- A. Product Data: For each type of product indicated.

1.04 QUALITY ASSURANCE

- A. Fire-Test-Response Characteristics: For fire-resistance-rated assemblies that incorporate non-load-bearing steel framing, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing agency.
- B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.

PART 2 - PRODUCTS

2.01 NON-LOAD-BEARING STEEL FRAMING, GENERAL

- A. Framing Members, General: Comply with ASTM C 754 for conditions indicated.

1. Steel Sheet Components: Comply with ASTM C 645 requirements for metal, unless otherwise indicated.
2. Protective Coating: ASTM A 653/A 653M, G60, hot-dip galvanized, unless otherwise indicated.

2.02 SUSPENSION SYSTEM COMPONENTS

- A. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.0625-inch- diameter wire, or double strand of 0.0475-inch- diameter wire.
- B. Hanger Attachments to Concrete:
 1. Anchors: Fabricated from corrosion-resistant materials with holes or loops for attaching wire hangers and capable of sustaining, without failure, a load equal to 5 times that imposed by construction as determined by testing according to ASTM E 488 by an independent testing agency.
 - a. Type: Post-installed, chemical anchor or post-installed, expansion anchor.
- C. Wire Hangers: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.162-inch diameter.
- D. Carrying Channels: Cold-rolled, commercial-steel sheet with a base-metal thickness of 0.0538 inch and minimum 1/2-inch- wide flanges.
 1. Depth: As indicated.
- E. Furring Channels (Furring Members):
 1. Cold-Rolled Channels: 0.0538-inch bare-steel thickness, with minimum 1/2-inch-wide flanges, 3/4 inch deep.
 2. Steel Studs: ASTM C 645.
 - a. Minimum Base-Metal Thickness: 0.0312 inch.
 - b. Depth: As indicated.
 3. Hat-Shaped, Rigid Furring Channels: ASTM C 645, 7/8 inch deep.
 - a. Minimum Base Metal Thickness: 0.0312 inch.
- F. Grid Suspension System for Ceilings: ASTM C 645, direct-hung system composed of main beams and cross-furring members that interlock.
 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 2. Products: Subject to compliance with requirements, provide one of the following:
 - a. Armstrong World Industries, Inc.; Drywall Grid Systems.

- b. Chicago Metallic Corporation; 640-C, Fire Front 650-C, 660-C Fire Front, or 670-C Drywall Furring System.
- c. USG Corporation; Drywall Suspension System.

2.03 STEEL FRAMING FOR FRAMED ASSEMBLIES

A. Steel Studs and Runners: ASTM C 645.

- 1. Minimum Base-Metal Thickness: 0.0179 inch, except provide 0.032-inch-thick steel studs and runners at the following locations:
 - a. For head runner, sill runner, jamb, and studs at door and other openings.
 - b. In locations to receive water-resistant gypsum board units and cementitious board units.
 - c. At partitions supporting heavy loads such as shelving, wall cabinets, and plumbing fixtures.
 - d. Where partitions exceed 10 feet in height, comply with stud depth and thickness requirements “Interior Framing Limiting Heights” table in USG Corporation “The Gypsum Construction Handbook – Centennial Edition.” Deflection shall not exceed $L/360$ for partitions indicated to receive tile finish.
 - e. Behind building expansion joints.
- 2. Provide 0.428-inch-thick studs at outside corners of corridor walls.
- 3. Depth: As indicated on Drawings.

B. Slip-Type Head Joints: Where indicated, provide the following:

- 1. Deflection Track: Steel sheet top runner manufactured to prevent cracking of finishes applied to interior partition framing resulting from deflection of structure above; in thickness not less than indicated for studs and in width to accommodate depth of studs.
 - a. Products: Subject to compliance with requirements, provide one of the following:
 - (1) Steel Network Inc. (The); VertiClip SLD Series.
 - (2) Superior Metal Trim; Superior Flex Track System (SFT).

C. Fire stop Tracks: Top runner manufactured to allow partition heads to expand and contract with movement of the structure while maintaining continuity of fire-resistance-rated assembly indicated; in thickness not less than indicated for studs and in width to accommodate depth of studs.

- 1. Products: Subject to compliance with requirements, provide one of the following:

- a. Fire Trak Corp.; Fire Trak attached to studs with Fire Trak Slip Clip.
 - b. Metal-Lite, Inc.; The System.
- D. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width indicated.
- 1. Minimum Base-Metal Thickness: 0.0312 inch.
- E. Hat-Shaped, Rigid Furring Channels: ASTM C 645.
- 1. Minimum Base Metal Thickness: 0.0312 inch.
 - 2. Depth: As indicated on Drawings.
- F. Resilient Furring Channels: 1/2-inch-deep members designed to reduce sound transmission.
- 1. Configuration: Asymmetrical or hat shaped.
- G. Z-Shaped Furring: With slotted or non-slotted web, face flange of 1-1/4 inches, wall attachment flange of 7/8 inch, minimum bare-metal thickness of 0.0179 inch, and depth required to fit insulation thickness indicated.

2.04 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that comply with referenced installation standards.
- 1. Fasteners for Metal Framing: Of type, material, size, corrosion resistance, holding power and other properties required to fasten steel members to substrates.
- B. Isolation Strip at Exterior Walls: Provide one of the following:
- 1. Asphalt-Saturated Organic Felt: ASTM D 226, Type I (No. 15 asphalt felt), non-perforated.
 - 2. Foam Gasket: Adhesive-backed, closed-cell vinyl foam strips that allow fastener penetration without foam displacement, 1/8 inch thick, in width to suit steel stud size.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine areas and substrates, with Installer present, and including welded hollow-metal frames, cast-in anchors, and structural framing, for compliance with requirements and other conditions affecting performance.
- 1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Suspended Assemblies: Coordinate installation of suspension systems with installation of overhead structure to ensure that inserts and other provisions for anchorages to building structure have been installed to receive hangers at spacing required to support the Work and that hangers will develop their full strength.
 - 1. Furnish concrete inserts and other devices indicated to other trades for installation in advance of time needed for coordination and construction.

3.03 INSTALLATION, GENERAL

- A. Installation Standard: ASTM C 754, except comply with framing sizes and spacing indicated.
 - 1. Portland Cement Plaster Assemblies: Also comply with requirements in ASTM C 1063 that apply to framing installation.
 - 2. Gypsum Board Assemblies: Also comply with requirements in ASTM C 840 that apply to framing installation.
- B. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.
- C. Install bracing at terminations in assemblies.
- D. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

3.04 INSTALLING SUSPENSION SYSTEMS

- A. Install suspension system components in sizes and spacing's indicated on Drawings, but not less than those required by referenced installation standards for assembly types and other assembly components indicated.
- B. Isolate suspension systems from building structure where they abut or are penetrated by building structure to prevent transfer of loading imposed by structural movement.
- C. Suspend hangers from building structure as follows:
 - 1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or suspension system.
 - a. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, counter-splaying, or other equally effective means.
 - 2. Where width of ducts and other construction within ceiling plenum produces hanger spacing that interfere with locations of hangers required to support standard suspension system members, install supplemental suspension members and hangers in the form of trapezes or equivalent devices.

- a. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced installation standards.
- 3. Wire Hangers: Secure by looping and wire tying, either directly to structures or to inserts, eye screws, or other devices and fasteners that are secure and appropriate for substrate, and in a manner that will not cause hangers to deteriorate or otherwise fail.
- 4. Flat Hangers: Secure to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices and fasteners that are secure and appropriate for structure and hanger, and in a manner that will not cause hangers to deteriorate or otherwise fail.
- 5. Do not connect or suspend steel framing from ducts, pipes, or conduit.
- D. Fire-Resistance-Rated Assemblies: Wire tie furring channels to supports.
- E. Grid Suspension Systems: Attach perimeter wall track or angle where grid suspension systems meet vertical surfaces. Mechanically join main beam and cross-furring members to each other and butt-cut to fit into wall track.
- F. Installation Tolerances: Install suspension systems that are level to within 1/8 inch in 12 feet measured lengthwise on each member that will receive finishes and transversely between parallel members that will receive finishes.

3.05 INSTALLING FRAMED ASSEMBLIES

- A. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.
- B. Install studs so flanges within framing system point in same direction.
 - 1. Space studs as follows:
 - a. Single-Layer Application: 16 inches o.c., unless otherwise indicated.
 - b. Multi-Layer Application: 16 inches o.c., unless otherwise indicated.
 - c. Tile backing panels: 16 inches o.c., unless otherwise indicated.
- C. Install tracks (runners) at floors and overhead supports. Extend framing full height to structural supports or substrates above suspended ceilings, except where partitions are indicated to terminate at suspended ceilings. Continue framing around ducts penetrating partitions above ceiling.
 - 1. Slip-Type Head Joints: Where framing extends to overhead structural supports, install to produce joints at tops of framing systems that prevent axial loading of finished assemblies.
 - 2. Door Openings: Screw vertical studs at jambs to jamb anchor clips on door frames; install runner track section (for cripple studs) at head and secure to jamb studs.

- a. Install two studs at each jamb, unless otherwise indicated.
 - b. Extend jamb studs through suspended ceilings and attach to underside of overhead structure.
 3. Other Framed Openings: Frame openings other than door openings the same as required for door openings, unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.
 4. Fire-Resistance-Rated Partitions: Install framing to comply with fire-resistance-rated assembly indicated and support closures and to make partitions continuous from floor to underside of solid structure.
 - a. Fire Stop Track: Where indicated, install to maintain continuity of fire-resistance-rated assembly indicated.
 5. Sound-Rated Partitions: Install framing to comply with sound-rated assembly indicated.
- D. Direct Furring:
1. Attach to concrete or masonry with stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches o.c.
- E. Z-Furring Members:
1. Erect insulation (specified in Division 7 Section "Building Insulation") vertically and hold in place with Z-furring members spaced 24 inches o.c.
 2. Except at exterior corners, securely attach narrow flanges of furring members to wall with concrete stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches o.c.
 3. At exterior corners, attach wide flange of furring members to wall with short flange extending beyond corner; on adjacent wall surface, screw-attach short flange of furring channel to web of attached channel. At interior corners, space second member no more than 12 inches from corner and cut insulation to fit.
- F. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch from the plane formed by faces of adjacent framing.

END OF SECTION 09 22 16

SECTION 09 24 00
CEMENT PLASTERING

PART 1 - GENERAL

1.01 DESCRIPTION

- A. This section specifies lathing and Portland cement based plaster (stucco).

1.02 RELATED DOCUMENTS

- A. SUMMARY OF WORK: Section 01 11 00:
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) Requirements
- B. Technical Special Provisions 09 91 00 - PAINTING

1.03 TERMINOLOGY

- A. Definitions and description of terms shall be in accordance with ASTM C11, C841, and C926 and as specified.
- B. Underside of Structure Overhead: In spaces where steel trusses or bar joists are shown, the underside of structure overhead shall be the underside of the floor or roof construction supported by beams, trusses, and bar joists.
- C. Self-furring Lath: Metal plastering bases having dimples or crimps designed to hold the plane of the back of the lath 6 to 10 mm (1/4 to 3/8 inch) away from the plane of the solid backing.
- D. Solid Backing or Solid Bases: Concrete, masonry, sheathing, rigid insulation, and similar materials to which plaster is directly applied.
- E. Wet Areas: Areas of a building where cyclic or continuous exposure to very humid or wet conditions, or in which a dew point condition may occur in the plaster. Dew point conditions occur frequently in such areas as shower rooms and similar areas.

1.04 SUBMITTALS

- A. Submit in accordance with Section 01 33 23, shop drawings, product data, and samples.
- B. Manufacturer's Literature and Data:
 - 1. Accessories for plaster, each type.
 - 2. Metal plastering bases, each type.
 - 3. Fasteners.
 - 4. Bonding compounds, including application instructions.

- 5. Admixtures, including mixing and application instructions.
- C. Samples: Accessories for plaster, each type, not less than 150 mm (6 inches) long.

1.05 PROJECT CONDITIONS

- A. Maintain work areas for interior work at a temperature of not less than 4°C (40°F) for not less than 48 hours prior to application of plaster, during application of plaster and until plaster is completely dry.
- B. Exterior plaster shall not be applied when the ambient temperature is less than 4°C (40°F).
- C. Plaster shall not be applied to frozen surfaces or surfaces containing frost.
- D. Frozen materials shall not be used in the mix.
- E. Plaster coats shall be protected against freezing for a period of not less than 24 hours after application.

1.06 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by basic designation only.
- B. American Society for Testing And Materials (ASTM):
 - 1. A653/A653M-10.....Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
 - 2. A641-09.....Zinc-Coated (Galvanized) Carbon Steel Wire
 - 3. C11-10.....Terminology Relating to Gypsum and Related Building Materials and Systems.
 - 4. C91-05.....Masonry Cement
 - 5. C150-09.....Portland Cement
 - 6. C207-06.....Hydrated Lime for Masonry Purposes
 - 7. C260-10.....Air Entraining Admixtures for Concrete.
 - 8. C841-08.....Installation of Interior Lathing and Furring
 - 9. C847-10.....Metal Lath
 - 10. C897-05(R2009).....Aggregate for Job-Mixed Portland Cement Based Plasters
 - 11. C926-06.....Application of Portland Cement-Based Plaster
 - 12. C933-09.....Welded Wire Lath

- 13. C979-10.....Pigments for Integrally Colored Concrete
- 14. C1002-07.....Steel Self-Piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs
- C. Commercial Item Description (CID):
 - 1. A-A-55615.....Shield, Expansion (Wood Screw and Lag Bolt Self Threading Anchors)
- D. Federal Specifications (Fed Spec.):
 - UU-B-790A.....Building Paper, Vegetable Fiber (Kraft, Waterproofed, Water Repellent and Fire Resistant)

PART 2 - PRODUCTS

2.01 METAL PLASTERING BASES

- A. Expanded Metal Lath:
 - 1. ASTM C847, zinc-coated (galvanized) except as modified by ASTM C841 and this specification. Self furring where applied over solid backing.
 - 2. Flat diamond mesh weighing not less than 1.8 kg/m² (3.4 pounds per square yard).
 - 3. Stucco Mesh: Flat expanded diamond mesh pattern, with openings approximately 38 by 75 mm (1-1/2 by 3 inches), weighing not less than 1.9 kg/ m² (3.6 pounds per square yard), with backing as specified.
 - 4. Recycled Content: Postconsumer recycled content plus one-half preconsumer recycled content not less than 25 percent.
- B. Wire Lath:
 - 1. Zinc coated (Galvanized).
 - 2. Welded Wire Lath: ASTM C933, with backing as specified.
 - 3. Self furring where applied over solid backing.
- C. Building Paper Backing for Metal Plastering Bases:
 - 1. Backing attached to lath as specified in ASTM C933.
 - 2. Vapor Permeable Backing: Fed. Spec. UU-B-790, Type I, Grade D.
 - 3. Water Resistant Backing: Fed. Spec. UU-B-790, Type I, Grade B.

2.02 ACCESSORIES FOR CEMENT PLASTER (STUCCO)

- A. ASTM C841, except fabricate from zinc alloy.
- B. Control Joints: ASTM C841, zinc.

2.03 FASTENERS

- A. Tie, wire, screws, clips, and other fasteners ASTM C841, except as otherwise specified.
- B. For securing metal plastering bases shall have heads, or be through washers large enough to engage two strands of the metal plastering base.
- C. For fire rated construction; type and size as used in fire rated test.
- D. Screws: ASTM C1002.
- E. Expansion Shields: CID A-A-55615, of the Type and Class applicable.

2.04 CEMENT

- A. Portland: ASTM C150, Type I.
- B. Masonry: ASTM C91. Lime where added, ASTM C207, Type S.
- C. White where required for white finish coat.

2.05 LIME

- A. ASTM C206, Type S.
- B. ASTM C207, Type S.

2.06 AGGREGATES (SAND)

- A. ASTM C897, graded as required to suit texture of finish specified.
- B. White where white finish coat is specified.

2.07 BONDING AGENT

- A. ASTM C932.

2.08 FACTORY PREPARED FINISH COAT FOR CEMENT PLASTER (STUCCO)

- A. Factory prepared dry blend of materials, integrally colored, designed for exterior finish coat application.
- B. Pigments: ASTM C979, lime proof mineral oxide.
- C. Not more than 35 percent, by weight of all ingredients (cement, aggregate, hydrated lime, admixture and coloring pigment) shall pass a number 100 sieve.

2.09 ADMIXTURES

- A. Air Entrainment: ASTM C260.

PART 3 - EXECUTION

3.01 METAL PLASTERING BASES (LATH) LOCATIONS

- A. Where plaster is required on solid concrete or masonry bases, metal plastering bases are not required, unless shown on the drawings. Where shown use wire lath or stucco mesh.
- B. On ceiling or soffit framing use flat diamond mesh lath.
- C. On interior wall framing:
 - 1. Use flat diamond mesh lath.
 - 2. Use lath with water resistant backing in wet areas.
- D. Over steel columns, use self-furring flat diamond mesh lath.
- E. Where metal plastering bases are used as a base for exterior cement plaster over wall sheathing, use wire lath or stucco mesh with water resistant backing.

3.02 APPLYING METAL PLASTERING BASES

- A. In accordance with ASTM C841, except as otherwise specified or shown.
- B. Form true surfaces, straight or in fair curves where shown, without sags or buckles and with long dimension of lath at right angles to direction of supports.
- C. Lath for ceiling or soffit construction shall terminate at casing bead (floating angle construction) at perimeter angles between walls and ceilings or soffits.
- D. Lath with backing shall be applied to produce a paper to paper and metal to metal lap at ends and sides of adjacent sheets, whether full sheets or less than full sheets are used:
 - 1. Backing shall be lapped 50 mm (2 inches) for both horizontal and vertical laps.
 - 2. Horizontal laps shall be ship lap fashion to conduct water to the outside and over flashing or waterproofing.
- E. Metal plastering bases shall not be continuous through expansion and control joints, but shall be stopped at each side.
- F. Attach metal lath directly to masonry and concrete with hardened nails, power actuated drive pins or other approved fasteners. Fasteners shall be located at the dimples or crimps only.
- G. Wood plugs are not acceptable.

3.03 INSTALLING PLASTERING ACCESSORIES

- A. Install accessories in accordance with ASTM C841, except as otherwise specified.
 - 1. Set plastering accessories plumb, level and true to line, neatly mitered at corners and intersections, and securely attach to supporting surfaces as specified for metal lath.
 - 2. Install in one piece, within the limits of the longest commercially available lengths.
- B. Corner Beads: Install at all vertical and horizontal external plaster corners, as required to establish grounds, and where shown.
- C. Strip Lath
 - 1. Install metal lath strips centered over joints between dissimilar materials, such as hollow tile, brick, concrete masonry units, concrete, and joints with metal lath on framing or furring, where both such surfaces are required to be plastered and are in contact with each other in same plane, except where expansion joints and casing beads are required.
 - 2. Wire tie or fasten strip lath to base along both edges at not over 150 mm (six inches) on centers.
- D. Casing Beads
 - 1. Install casing beads where shown and at following locations where plaster terminates to provide finish trim.
 - 2. Where plaster terminates against non-plastered surfaces such as masonry, concrete, and wood.
 - 3. Where plaster terminates against trim of steel frames and trim of other materials and equipment, except where trim overlaps plaster.
 - 4. Around perimeter of openings except where edge is covered by flanges. Locate to conform to dimensions shown on shop drawings.
 - 5. Where plaster for new walls or furring (vertical or horizontal) terminates against existing construction.
 - 6. Both sides of expansion and control joints unless shown otherwise.
 - 7. Install casing bead at perimeter angles between walls and ceilings so as to provide floating angle (unrestrained) construction in accordance with ASTM C841.
- E. Cornerites
 - 1. Install at interior corners of walls, partitions, and other vertical surfaces to be plastered, except where metal lath is carried around angle.
 - 2. Fasten only as necessary to retain position during plastering.

3. Omit cornerites at junction of new plastered walls with existing plastered walls at locations where casing beads are specified.

F. Control Joints:

1. Where control joints are placed parallel to framing members, install joints within 100 mm (four inches) of the framing member.
2. Install control joints only to the edges of abutting sheets of lath so that the lath is not continuous or tied across the joint.
3. Joints shall extend the full width and height of the wall or length of soffit/ceiling plaster membrane.

3.04 SURFACE PREPARATION OF SOLID BASES

- A. Surfaces that are to receive plaster shall be prepared and conditioned in accordance with ASTM C926, except as otherwise specified.
- B. New surfaces of masonry and concrete:
 1. Remove projections and clean concrete surface of form oil.
 2. Fill depressions, holes, cracks and similar voids flush with Portland cement plaster to provide substrate within the tolerance specified in ASTM C926.
 3. Use bonding agent.
 4. Cover with self furring lath where required to keep the total plaster thickness as specified in Table 4 of ASTM C926.

3.05 PORTLAND CEMENT BASED PLASTER

- A. Provide Portland cement based plaster where cement plaster (stucco) is shown and specified, and as follows:
 1. Three coat work shall be used over all metal plastering bases, with or without solid backing.
- B. Proportion, mix and apply plaster in accordance with ASTM C926, except as otherwise specified.
 1. Use air entrained plaster for all exterior work.
 2. Use coloring pigments for finish coat when integral color other than white is specified.
 3. Use white cement with white sand when white finish coat is specified.
 4. Factory prepared finish coat: Add water, mix, and apply as specified by manufacturer.

5. Color: Color of finish coat shall be natural cement color when painted or other coating is specified.
6. Finish coat shall be sand float texture.

END OF SECTION 09 24 00

SECTION 09 29 00
GYPSUM BOARD

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. SUMMARY OF WORK: Section 01 11 00:
 - 1. Refer to "PART 2 – PRODUCTS" for all Buy America Build America Act (BABA) Requirements

1.02 SUMMARY

- A. This Section includes the following:
 - 1. Interior gypsum board.
 - 2. Tile backing panels.
 - 3. Flush access doors.

1.03 SUBMITTALS

- A. Product Data: For each type of product indicated.

1.04 QUALITY ASSURANCE

- A. Fire-Resistance-Rated Assemblies (if applicable): For fire resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing agency.
- B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.

1.05 STORAGE AND HANDLING

- A. Store materials inside enclosed building under cover and keep them dry and protected against damage from weather, condensation, direct sunlight, construction traffic, and other causes. Stack panels flat to prevent sagging.

1.06 PROJECT CONDITIONS

- A. Environmental Limitations: Comply with ASTM C 840 requirements or gypsum board manufacturer's written recommendations, whichever are more stringent.
- B. Do not install interior products until installation areas are enclosed and conditioned.

- C. Do not install panels that are wet, those that are moisture damaged, and those that are mold damaged.
 - 1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
 - 2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

PART 2 - PRODUCTS

2.01 PANELS, GENERAL

- A. Recycled Content: Provide gypsum panel products with recycled content such that postconsumer recycled content plus one-half of preconsumer recycled content constitutes a minimum of 25 percent by weight.
- B. Size: Provide in maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.
- C. Provide regionally manufactured materials.

2.02 INTERIOR GYPSUM BOARD

- A. General: Complying with ASTM C 1396/C 1396M, as applicable to type of gypsum board indicated and whichever is more stringent.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. USG Corporation.
 - b. National Gypsum.
 - c. CertainTeed.
 - d. Or approved equal.
- B. Gypsum Wallboard, Regular: ASTM C1396/ C1396:
 - 1. Thickness: 5/8 inch unless otherwise indicated on drawings
 - 2. Long Edges: Tapered.
- C. Gypsum Wallboard Type X: ASTM C1396/ C1396:
 - 1. Thickness: 5/8 inch unless otherwise indicated on drawings.
 - 2. Long Edges: Tapered.
- D. Gypsum Ceiling Board: ASTM C1396/ C1396:

1. Thickness: 5/8 inch.
 2. Long Edges: Tapered.
- E. Abuse-Resistant Gypsum Board: ASTM C1629/ C1629M Level 2:
1. Thickness: Core 5/8 inch unless otherwise indicated on drawings.
 2. Long Edges: Tapered.
 3. Mold Resistance: ASTM D3273, Score of 10.
- F. Moisture and Mold resistance Gypsum Board; ASTM C1396/ C1396M. With moisture and mold resistant core and paper core and paper surfaces.
1. Thickness: Core 5/8 inch unless otherwise indicated on drawings.
 2. Long Edges: Tapered.
 3. Mold Resistance: ASTM D3273, Score of 10.

2.03 TILE BACKING PANELS

- A. Cementitious Backer Units: ANSI A118.9.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. USG Corporation.
 - b. James Hardie.
 - c. Or approved equal.
 2. Thickness: 1/2 inch minimum, unless otherwise indicated on drawings.
 3. Mold Resistance: ASTM D3273, Score of 10.
 4. Provide at all areas to receive tile finish, and as indicated on the Plans.

2.04 TRIM ACCESSORIES

- A. Interior Trim: ASTM C 1047.
1. Material: Metal.
 2. Shapes:
 - a. Cornerbead.
 - b. Bullnose bead.
 - c. LC-Bead: J-shaped; exposed long flange receives joint compound.

- d. L-Bead: L-shaped; exposed long flange receives joint compound.
- e. U-Bead: J-shaped; exposed short flange does not receive joint compound.
- f. Expansion (control) joint.

2.05 JOINT TREATMENT MATERIALS

- A. General: Comply with ASTM C 475/C 475M.
- B. Joint Tape:
 - 1. Interior Gypsum Wallboard: Paper.
 - 2. Tile Backing Panels: As recommended by panel manufacturer.
- C. Joint Compound for Interior Gypsum Wallboard: For each coat use formulation that is compatible with other compounds applied on previous or for successive coats.
 - 1. Prefilling: At open joints, rounded or beveled panel edges, and damaged surface areas, use setting-type taping compound.
 - 2. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use setting-type taping compound.
 - a. Use setting-type compound for installing paper-faced metal trim accessories.
 - 3. Fill Coat: For second coat, use setting-type, sandable topping compound.
 - 4. Finish Coat: For third coat, use setting-type, sandable topping compound.
- D. Joint Compound for Tile Backing Panels:
 - 1. Cementitious Backer Units: As recommended by backer unit manufacturer.

2.06 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written recommendations.
- B. Laminating Adhesive: Adhesive or joint compound recommended for directly adhering gypsum panels to continuous substrate.
 - 1. Use adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- C. Steel Drill Screws: ASTM C 1002, unless otherwise indicated.
 - 1. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.

- D. Sound Attenuation Blankets: ASTM C 665, Type I (blankets without membrane facing) produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool.
 - 1. Fire-Resistance-Rated Assemblies: Comply with mineral-fiber requirements of assembly.
 - 2. Recycled Content: Provide blankets with recycled content such that postconsumer recycled content plus one-half of preconsumer recycled content constitutes a minimum of 25 percent by weight.
 - 3. Maximize thickness to friction fit snug within metal stud cavity.

2.07 FLUSH ACCESS DOORS

- A. Provide flush installed access doors with integral rim cylinder locking mechanism.
 - 1. Size and locations as indicated on the Plans.
- B. Provide sufficient framing and blocking as required to install access doors in walls and ceilings per manufacturer's standard written instructions.
- C. Access doors shall meet the following criteria:
 - 1. 20 gauge minimum galvanized formed door panels with flanges on all four sides.
 - 2. 26 gauge minimum galvanized frame with integral perforated tapping bead for flush installation
 - 3. Concealed heavy duty pin hinges.
 - 4. Rim cylinder locking mechanism. Coordinate with Owner and refer to Section 08 71 00 DOOR HARDWARE for additional information related to hardware and keying requirements.
 - 5. Finish: Manufacturer's standard baked-on polyester powder coating. Color to be selected by Architect from manufacturer's full range.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine areas and substrates, with Installer present, and including welded hollow-metal frames and framing, for compliance with requirements and other conditions affecting performance.
- B. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 APPLYING AND FINISHING PANELS, GENERAL

- A. Comply with ASTM C 840.
- B. Install ceiling panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.
- C. Install panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16 inch of open space between panels. Do not force into place.
- D. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.
- E. Form control and expansion joints with space between edges of adjoining gypsum panels.
- F. Cover both faces of support framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally.
 - 1. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 8 sq. ft. in area.
 - 2. Fit gypsum panels around ducts, pipes, and conduits.
 - 3. Where partitions intersect structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by structural members; allow 1/4- to 3/8-inch- wide joints to install sealant.
 - 4. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments, including floors. Provide 1/4- to 1/2-inch- wide spaces at these locations, and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.
- G. Attachment to Steel Framing: Attach panels so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.
- H. STC-Rated Assemblies and Partitions indicated to receive Sound Insulation: Seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Comply with ASTM C 919 and with manufacturer's written recommendations for locating edge trim and closing off sound-flanking paths around or through assemblies, including sealing partitions above acoustical ceilings.
- I. Install sound attenuation blankets before installing gypsum panels, unless blankets are readily installed after panels have been installed on one side.

3.03 APPLYING INTERIOR GYPSUM BOARD

- A. Install interior gypsum board in the following locations:

1. Type X: At vertical and horizontal surfaces where regular or Type X is indicated.
 2. Type C: Where required for specific fire-resistance-rated assembly indicated.
- B. Single-Layer Application:
1. On ceilings, apply gypsum panels before wall/partition board application to greatest extent possible and at right angles to framing, unless otherwise indicated.
 2. On partitions/walls, apply gypsum panels vertically (parallel to framing), unless otherwise indicated or required by fire-resistance-rated assembly, and minimize end joints.
 - a. Stagger abutting end joints not less than one framing member in alternate courses of panels.
 3. On Z-furring members, apply gypsum panels vertically (parallel to framing) with no end joints. Locate edge joints over furring members.
 4. Fastening Methods: Apply gypsum panels to supports with steel drill screws.
- C. Multilayer Application:
1. On ceilings, apply gypsum board indicated for base layers before applying base layers on walls/partitions; apply face layers in same sequence. Apply base layers at right angles to framing members and offset face-layer joints 1 framing member, 16 inches minimum, from parallel base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly.
 2. Fastening Methods: Fasten base layers and face layers separately to supports with screws.
- D. Laminating to Substrate: Where gypsum panels are indicated as directly adhered to a substrate (other than studs, joists, furring members, or base layer of gypsum board), comply with gypsum board manufacturer's written recommendations and temporarily brace or fasten gypsum panels until fastening adhesive has set.

3.04 APPLYING TILE BACKING PANELS

- A. Cementitious Backer Units: ANSI A108.11, at locations indicated to receive tile.
- B. Where tile backing panels abut other types of panels in same plane, shim surfaces to produce a uniform plane across panel surfaces.

3.05 INSTALLING TRIM ACCESSORIES

- A. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.
- B. Control Joints: Install control joints according to ASTM C 840 and in specific locations as approved by Architect for best aesthetic effect. Notify Architect of surfaces exceeding the

maximum lengths or requirements to coordinate control joint locations prior to installation of gypsum board.

C. Interior Trim: Install in the following locations:

1. Cornerbead: Use at outside corners.
2. LC-Bead: Use at exposed panel edges.
3. L-Bead: Use where indicated.

3.06 FINISHING GYPSUM BOARD

A. General: Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.

B. Prefill open joints, rounded or beveled edges, and damaged surface areas.

C. Apply joint tape over gypsum board joints, except those with trim having flanges not intended for tape.

D. Gypsum Board Finish Levels: Finish panels to levels indicated below and according to ASTM C 840:

1. Level 1: Ceiling plenum areas, concealed areas, and where indicated.
2. Level 4: Typical unless otherwise indicated. Not to be used in concealed spaces and public areas.
3. Level 5: Lobby, waiting areas and public corridors.

3.07 PROTECTION

A. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during the remainder of the construction period.

B. Remove and replace panels that are wet, moisture damaged, and mold damaged.

1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
2. Indications that panels are mold damaged include, but are not limited to, fuzzy or blotchy surface contamination and discoloration.

END OF SECTION 09 29 00

SECTION 09 30 13
TILE WORK

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes:
 - 1. Large format porcelain wall tile and integral cove base.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00:
 - 1. Refer to "PART 2 – PRODUCTS" for all Buy America Build America Act (BABA) Requirements
- B. CAST-IN-PLACE CONCRETE: Section 03 30 00.
- C. GYPSUM BOARD - 09 29 00.

1.03 QUALITY ASSURANCE

- A. Installer's Qualifications: Installation shall be performed only by a qualified installer with at least five (5) years documented experience in installations of a similar nature.
- B. Reference Standards: Comply with provisions of the following, unless otherwise indicated or specified:
 - 1. Tile Council of America (TCA):
 - a. Handbook for Ceramic Tile Installation.
 - 2. American National Standards Institute (ANSI):
 - a. ANSI A108.10 "Specifications for Installation of Grout in Tile Work."
 - b. ANSI A118.4 "Specifications for Latex-Portland Cement Mortar."
 - c. ANSI A137.1 "Specifications for Ceramic Tile."
 - 3. American Society for Testing and Materials (ASTM):
 - a. Referenced Standards.
 - 4. Americans with Disabilities Act (ADA):
 - a. Referenced Standards for Shower Accessories.
- C. Source of Materials: Provide materials obtained from one source for each type and color of grout and setting materials.

1.04 SUBMITTALS

- A. Schedule of Tile Materials: Submit schedule of all tile materials proposed for use.
- B. Product Data: Submit manufacturer's technical information and installation instructions for materials required, except bulk materials.
- C. Shop Drawings: Submit shop drawings indicating tile patterns and locations and widths of expansion, contraction, control, and isolation joints in tile substrates and finished tile surfaces. Locate precisely each joint and crack in tile substrates by measuring, record measurements on shop drawings, and coordinate them with tile joint locations, in consultation with Engineer.
- D. Samples: Submit samples of the following:
 - 1. Samples for each type of tile and for each color and texture required, not less than 12 inches square, on plywood or hardboard backing and grouted.
 - 2. Three (3) samples of the specified marble material for thresholds. Submit finished samples in 6 inch lengths.
 - 3. Samples shall be representative of all color range extremities and individually identified by numbers placed on the samples.
 - 4. Installed materials shall match approved samples.
- E. Installer Qualifications: Submit documented evidence of installer's qualifications.

1.05 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. All porcelain tile shall be graded and containers grade-sealed in accordance with minimum grade specifications established in ANSI A137.1.
- B. Deliver and store packaged materials in original containers with seals unbroken and labels intact until time of use. Store and handle materials in a manner to prevent damage or contamination with water or foreign matter.

1.06 PROJECT CONDITIONS

- A. Protect the adjoining surfaces and the work of other trades at all times.
- B. Maintain environmental conditions and protect work during and after installation to comply with referenced standards and manufacturer's printed recommendations.

PART 2 - PRODUCTS

2.01 TYPE

- A. Basis of Design Product: DACTILE Large format 12" x 24" or 24" x 48" nominal, rectified edge, color through porcelain tile. Refer to Plans for tile locations. Note patterns shown as reference. Differing tile selections and sizes shall be coordinated during construction.

2.02 GROUT

- A. 1/8" wide industrial grade epoxy grout system as manufactured by:
 - 1. Bostik.
 - 2. Mapei Corp.
 - 3. Laticrete International, Inc.

2.03 MATERIALS

- A. Tile: Porcelain floor tile, wall tile, integral sanitary cove base, accent tiles/strips, and all Trim required:
 - 1. Standard Grade conforming to ANSI A137.1.
 - 2. Type/Color: As indicated use on Plans.
 - 3. Suitable for use on wet location interior floors, walls, and exterior walls
 - 4. Cove Base Basis of Design: Schluter®-DILEX-AHKA

2.04 TILE AND SETTING AND GROUTING MATERIALS

- A. Latex-Portland Cement Mortar: ANSI A118.1, composition as follows:
 - 1. Manufacturer's standard latex additive (water emulsion), serving as replacement for part or all of gauging water, combined at job site with prepackaged dry mortar mix supplied or specified by latex additive manufacturer.
 - 2. Products: Provide one of the following:
 - a. "Hydroment Tile-Mate" with "Hydroment Multi-Purpose Acrylic Latex 425"; Bostik.
 - b. "Laticrete 272 Premium Floor and Wall Thin-Set Mortar" with "Laticrete 3701 Mortar Admix"; Laticrete International, Inc.
 - c. "KERABOND" with "KERAPLASTIC"; Mapei Corp.
- B. Chemical-Resistant, Water-Cleanable, Tile-Grouting Epoxy: ANSI A118.3.
 - 1. Provide product capable of withstanding continuous and intermittent exposure to temperatures of up to 140 deg F. and 212 deg F., respectively, and certified by manufacturer for intended use.
 - 2. As indicated on Plans or as selected by Engineer from manufacturer's standard range.
 - 3. Products: Provide one of the following:

- a. "Hydroment Color-Poxy"; Bostik.
- b. "Laticrete 2000 Industrial Epoxy Grout"; Laticrete International, Inc.
- c. "KER 400 Series KERAPOXY"; Mapei Corp.

2.05 MISCELLANEOUS MATERIALS

A. One-Part Mildew Resistant Silicone Sealant:

- 1. ASTM C 920; Type S; Grade NS; Class 25; Uses NT, G, A, and as applicable to nonporous joint substrates indicated, O; formulated with fungicide for sealing interior ceramic tile corners, and joints in and around porcelain tile with plumbing fixtures.
 - a. Provide by same manufacturer as grout and setting materials.
- 2. Products: Provide one of the following:
 - a. "Chem-Calk 900"; Bostik.
 - b. "Dow Corning 786"; Dow Corning Corp.
 - c. "Sanitary 1700"; GE Silicones.

- B. Tile Cleaner: Product specifically acceptable to manufacturer of tile and grout manufacturer for application indicated and as recommended by the Ceramic Tile Institute of America (CTI).

PART 3 - EXECUTION

3.01 INSPECTION AND PREPARATION

- A. Prior to commencement of work, all substrates to receive tile work shall be inspected to assure that the surfaces are ready for tile application. All surfaces shall be dry, clean and free of oily or waxy films. Do not proceed with work until surfaces and conditions comply with requirements indicated in referenced tile installation standard.
- B. Do not start work until Electrical and Mechanical work in or behind tile work has been completed.

3.02 INSTALLATION, GENERAL

- A. ANSI Tile Installation Standard: Comply with applicable parts of ANSI 108 series of tile installation standards included under "American National Standard Specifications for the Installation of Ceramic Tile."
- B. TCA Installation Guidelines: TCA "Handbook for Ceramic Tile Installation;" comply with TCA installation methods indicated or, if not otherwise indicated, as applicable to installation conditions shown.
- C. Determine location of all movement joints before starting tilework.

- D. Extend tile work into recesses and under or behind equipment and fixtures, to form a complete covering without interruptions, except as otherwise shown. Terminate work neatly at obstructions, edges and corners without disruption of pattern or joint alignments. Extend accent tiles to abut door jambs. Use bullnose tiles at door jambs.
- E. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish or built-in items for straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures and other penetrations so that plates, collars or covers overlap tile. Ensure that cut tiles occur in the most inconspicuous locations.
- F. Jointing Pattern: Unless otherwise shown, lay tile in grid pattern. Align joints when adjoining tiles on floor, base, walls and trim are same size. Layout tile work and center tile fields in both directions in each space or on each wall area. Adjust to minimize tile cutting. Provide uniform joint widths, unless otherwise shown. Joints in floor tile and vertical joints in wall tile shall match.
- G. DO NOT use less than 1/2 tile at any location.
- H. Grout tile to comply with ANSI A108.10, using grout materials indicated.
- I. Mix and install proprietary components to comply with grout manufacturer's directions.
- J. Marble thresholds and trim to have all exposed faces smooth finished.

3.03 INSTALLATION METHODS

- A. Install Tile to comply with requirements indicated below for setting bed methods, ANSI, and TCA installation methods related to types of substrate construction.
- B. Tile Walls:
 - 1. Latex-Portland Cement Mortar and Epoxy Grout: ANSI A108.5.
 - a. Concrete Masonry Units, Interior: TCA W243.

3.04 CLEANING AND PROTECTION

- A. Upon completion of placement and grouting, clean all ceramic tile surfaces so they are free of foreign matter.
- B. Unglazed tile may be cleaned with acid solutions only when permitted by tile and grout manufacturer's printed instructions, but not sooner than 14 days after installation. Protect metal surfaces, cast iron and vitreous plumbing fixtures from the effects of acid cleaning. Flush surface with clean water before and after cleaning.
- C. Leave finished installation clean and free of cracked, chipped, broken, unbonded, or otherwise defective tile work.
- D. When recommended by tile manufacturer, apply a protective coat of neutral protective cleaner to completed tile walls and floors. Protect installed tile work with Kraft paper or other heavy covering during construction period to prevent damage and wear.

- E. Prohibit foot and wheel traffic from using tiled floors for at least 3 days after grouting is completed.

3.05 EXTRA STOCK

- A. Upon completion of work, deliver to the Owner extra tile of size and color used on the job, for use in future repair and maintenance work. Furnish tile in original boxes, properly marked, in quantities as listed below and in types and colors as directed.
 - 1. Wall Tile: 3 percent of total quantity of each color.

END OF SECTION 09 30 13

SECTION 09 51 13
ACOUSTICAL PANEL CEILINGS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. SUMMARY OF WORK: Section 01 11 00:
 - 1. Refer to "PART 2 – PRODUCTS" for all Buy America Build America Act (BABA) Requirements

1.02 SUMMARY

- A. Section includes acoustical panels and exposed suspension systems for ceilings.
- B. Products furnished, but not installed under this Section, include anchors, clips, and other ceiling attachment devices to be cast in concrete.

1.03 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at project site.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product.

1.05 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Suspended ceiling components.
 - 2. Structural members to which suspension systems will be attached.
 - 3. Size and location of initial access modules for acoustical panels.
 - 4. Items penetrating finished ceiling including the following:
 - a. Lighting fixtures.
 - b. Air outlets and inlets.
 - c. Speakers.
 - d. Sprinklers.

- e. Access panels.
 - 5. Perimeter moldings.
 - B. Qualification Data: For testing agency.
 - C. Product Test Reports: For each acoustical panel ceiling, for tests performed by manufacturer and witnessed by a qualified testing agency.
 - D. Evaluation Reports: For each acoustical panel ceiling suspension system and anchor and fastener type, from ICC-ES.
 - E. Field quality-control reports.
- 1.06 CLOSEOUT SUBMITTALS
 - A. Maintenance Data: For finishes to include in maintenance manuals.
- 1.07 MAINTENANCE MATERIAL SUBMITTALS
 - A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Acoustical Ceiling Panels: Full-size panels equal to 2 percent of quantity installed.
 - 2. Suspension-System Components: Quantity of each exposed component equal to 2 percent of quantity installed.
 - 3. Hold-Down Clips: Equal to 2 percent of quantity installed.
 - 4. Impact Clips: Equal to 2 percent of quantity installed.
- 1.08 QUALITY ASSURANCE
 - A. Testing Agency Qualifications: Qualified according to NVLAP for testing indicated.
 - B. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
 - 1. Build mockup of typical ceiling area as shown on Drawings.
 - 2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
- 1.09 DELIVERY, STORAGE, AND HANDLING
 - A. Deliver acoustical panels, suspension-system components, and accessories to Project site in original, unopened packages and store them in a fully enclosed, conditioned space where they will be protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.
 - B. Before installing acoustical panels, permit them to reach room temperature and stabilized

moisture content.

- C. Handle acoustical panels carefully to avoid chipping edges or damaging units in any way.

1.10 FIELD CONDITIONS

- A. Environmental Limitations: Do not install acoustical panel ceilings until spaces are enclosed and weatherproof, wet work in spaces is complete and dry, work above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
 - 1. Pressurized Plenums: Operate ventilation system for not less than 48 hours before beginning acoustical panel ceiling installation.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Acoustical ceiling shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
- B. Fire-Resistance Ratings: Comply with ASTM E 119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.

2.02 ACOUSTICAL PANELS, GENERAL

- A. Low-Emitting Materials: Acoustical panel ceilings shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- B. Source Limitations:
 - 1. Acoustical Ceiling Panel: Obtain each type from single source from single manufacturer.
 - 2. Suspension System: Obtain each type from single source from single manufacturer.
- C. Source Limitations: Obtain each type of acoustical ceiling panel and supporting suspension system from single source from single manufacturer.
- D. Recycled Content: Postconsumer recycled content plus one-half of pre-consumer recycled content not less than 50% percent.
- E. Glass-Fiber-Based Panels: Made with binder containing no urea formaldehyde.
- F. Acoustical Panel Standard: Provide manufacturer's standard panels of configuration indicated that comply with ASTM E 1264 classifications as designated by types, patterns,

acoustical ratings, and light reflectance unless otherwise indicated.

1. Mounting Method for Measuring NRC: Type E-400; plenum mounting in which face of test specimen is 15-3/4 inches (400 mm) away from test surface according to ASTM E 795.
- G. Acoustical Panel Colors and Patterns: Match appearance characteristics indicated for each product type.
1. Where appearance characteristics of acoustical panels are indicated by referencing pattern designations in ASTM E 1264 and not manufacturers' proprietary product designations, provide products selected by Architect from each manufacturer's full range that comply with requirements indicated for type, pattern, color, light reflectance, acoustical performance, edge detail, and size.

2.03 MANUFACTURERS/ PRODUCT

- A. Provide Certainteed Saint-Gobain Seismic Secure Suspension Systems:
1. Classic Stab System
 2. Finish: White, fine texture
 3. LR: Not less than 0.88.
 4. NRC: Not less than 0.75.
 5. CAC: Not less than 35
 6. Edge/Joint Detail: Beveled Tegular.
 7. Thickness: 3/4 inch minimum.
 8. Modular Size: 24 by 24 inches (610 by 610 mm).
 9. Grid: 15/16 inch-white.
 10. Class A Finish

2.04 METAL SUSPENSION SYSTEMS, GENERAL

- A. Recycled Content: Postconsumer recycled content plus one-half of pre-consumer recycled content not less than 25 percent.
- B. Metal Suspension-System Standard: Provide manufacturer's standard direct-hung metal suspension systems of types, structural classifications, and finishes indicated that comply with applicable requirements in ASTM C 635/C 635M.
- C. Attachment Devices: Size for five times the design load indicated in ASTM C 635/C 635M, Table 1, "Direct Hung," unless otherwise indicated. Comply with seismic design requirements.

1. Anchors in Concrete: Anchors of type and material indicated below, with holes or loops for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to five times that imposed by ceiling construction, as determined by testing according to ASTM E 488 or ASTM E 1512 as applicable, conducted by a qualified testing and inspecting agency.
 - a. Type: Post installed expansion anchors.
 - b. Corrosion Protection: Carbon-steel components zinc plated to comply with ASTM B 633, Class Fe/Zn 5 for Class SC 1 service condition.
 - c. Corrosion Protection: Stainless-steel components complying with ASTM F 593 and ASTM F 594, Group 1 Alloy 304 or 316 for bolts; Alloy 304 or 316 for anchor.
 - d. Corrosion Protection: Components fabricated from nickel-copper-alloy rods complying with ASTM B 164 for UNS No. N04400 alloy.
 2. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to 10 times that imposed by ceiling construction, as determined by testing according to ASTM E 1190, conducted by a qualified testing and inspecting agency.
- D. Wire Hangers, Braces, and Ties: Provide wires complying with the following requirements:
1. Zinc-Coated, Carbon-Steel Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper.
 2. Stainless-Steel Wire: ASTM A 580/A 580M, Type 304, nonmagnetic.
 3. Nickel-Copper-Alloy Wire: ASTM B 164, nickel-copper-alloy UNS No. N04400.
 4. Size: Select wire diameter so its stress at three times hanger design load (ASTM C 635/C 635M, Table 1, "Direct Hung") will be less than yield stress of wire, but provide not less than 0.106-inch- (2.69-mm-) diameter wire.
- E. Angle Hangers: Angles with legs not less than 7/8 inch (22 mm) wide; formed with 0.04-inch- (1-mm-) thick, galvanized-steel sheet complying with ASTM A 653/A 653M, G90 (Z275) coating designation; with bolted connections and 5/16-inch- (8-mm-) diameter bolts.
- F. Seismic Stabilizer Bars: Manufacturer's standard perimeter stabilizers designed to accommodate seismic forces.
- G. Seismic Struts: Manufacturer's standard compression struts designed to accommodate seismic forces.
- H. Seismic Clips: Manufacturer's standard seismic clips designed and spaced to secure acoustical panels in place.

- I. Hold-Down Clips: Where indicated, provide manufacturer's standard hold-down clips spaced 24 inches (610 mm) o.c. on all cross tees.
- J. Impact Clips: Where indicated, provide manufacturer's standard impact-clip system designed to absorb impact forces against acoustical panels.

2.05 METAL SUSPENSION SYSTEM.

- A. Narrow-Face, Capped, Double-Web, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet; pre-painted, electrolytically zinc coated, or hot-dip galvanized according to ASTM A 653/A 653M, not less than G30 (Z90) coating designation; with prefinished 15/16 inch wide metal caps on flanges.
 - 1. Structural Classification: Intermediate-duty system.
 - 2. End Condition of Cross Runners: Override (stepped) type.
 - 3. Face Design: Flat, flush.
 - 4. Cap Material: Steel or aluminum cold-rolled sheet.
 - 5. Cap Finish: Painted in color as selected from manufacturer's full range.

2.06 METAL EDGE MOLDINGS AND TRIM

- A. Roll-Formed, Sheet-Metal Edge Moldings and Trim: Type and profile indicated or, if not indicated, manufacturer's standard moldings for edges and penetrations that comply with seismic design requirements; formed from sheet metal of same material, finish, and color as that used for exposed flanges of suspension-system runners.
 - 1. Provide manufacturer's standard edge moldings that fit acoustical panel edge details and suspension systems indicated and that match width and configuration of exposed runners unless otherwise indicated.
 - 2. For lay-in panels with reveal edge details, provide stepped edge molding that forms reveal of same depth and width as that formed between edge of panel and flange at exposed suspension member.
 - 3. For circular penetrations of ceiling, provide edge moldings fabricated to diameter required to fit penetration exactly.

2.07 ACOUSTICAL SEALANT

- A. Acoustical Sealant: Manufacturer's standard sealant complying with ASTM C 834 and effective in reducing airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.
 - 1. Exposed and Concealed Joints: Non-sag, paintable, non-staining latex sealant.
 - 2. Concealed Joints: Nondrying, non-hardening, non-skinning, non-staining,

gunnable, synthetic-rubber sealant.

3. Acoustical sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, including structural framing to which acoustical panel ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage and with requirements for installation tolerances and other conditions affecting performance of acoustical panel ceilings.
- B. Examine acoustical panels before installation. Reject acoustical panels that are wet, moisture damaged, or mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Measure each ceiling area and establish layout of acoustical panels to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width panels at borders, and comply with layout shown on reflected ceiling plans.

3.03 INSTALLATION

- A. General: Install acoustical panel ceilings to comply with ASTM C 636/C 636M and seismic design requirements indicated, according to manufacturer's written instructions and CISCA's "Ceiling Systems Handbook."
 1. Fire-Rated Assembly: Install fire-rated ceiling systems according to tested fire-rated design.
- B. Suspend ceiling hangers from building's structural members and as follows:
 1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.
 2. Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
 3. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension-system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices.
 4. Secure wire hangers to ceiling-suspension members and to supports above with a minimum of three tight turns. Connect hangers directly either to structures or to inserts, eye screws, or other devices that are secure and appropriate for substrate

and that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.

5. Secure flat, angle, channel, and rod hangers to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices that are secure and appropriate for both the structure to which hangers are attached and the type of hanger involved. Install hangers in a manner that will not cause them to deteriorate or fail due to age, corrosion, or elevated temperatures.
 6. Do not support ceilings directly from permanent metal forms or floor deck. Fasten hangers to cast-in-place hanger inserts, post-installed mechanical or adhesive anchors, or power-actuated fasteners that extend through forms into concrete.
 7. When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.
 8. Do not attach hangers to steel deck tabs.
 9. Do not attach hangers to steel roof deck. Attach hangers to structural members.
 10. Space hangers not more than 48 inches (1200 mm) o.c. along each member supported directly from hangers unless otherwise indicated; provide hangers not more than 8 inches (200 mm) from ends of each member.
 11. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards and publications.
- C. Secure bracing wires to ceiling suspension members and to supports with a minimum of four tight turns. Suspend bracing from building's structural members as required for hangers, without attaching to permanent metal forms, steel deck, or steel deck tabs. Fasten bracing wires into concrete with cast-in-place or post-installed anchors.
- D. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical panels.
1. Apply acoustical sealant in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.
 2. Screw attach moldings to substrate at intervals not more than 16 inches (400 mm) o.c. and not more than 3 inches (75 mm) from ends, leveling with ceiling suspension system to a tolerance of 1/8 inch in 12 feet (3.2 mm in 3.6 m). Miter corners accurately and connect securely.
 3. Do not use exposed fasteners, including pop rivets, on moldings and trim.
- E. Install suspension-system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.
- F. Install acoustical panels with undamaged edges and fit accurately into suspension-system runners and edge moldings. Scribe and cut panels at borders and penetrations to provide a

neat, precise fit.

1. For square-edged panels, install panels with edges fully hidden from view by flanges of suspension-system runners and moldings.
2. For reveal-edged panels on suspension-system runners, install panels with bottom of reveal in firm contact with top surface of runner flanges.
3. Paint cut edges of panel remaining exposed after installation; match color of exposed panel surfaces using coating recommended in writing for this purpose by acoustical panel manufacturer.
4. Install hold-down and impact clips in areas indicated, in areas required by authorities having jurisdiction, and for fire-resistance ratings; space as recommended by panel manufacturer's written instructions unless otherwise indicated.
5. Install clean-room gasket system in areas indicated, sealing each panel and fixture as recommended by panel manufacturer's written instructions.
6. Protect lighting fixtures and air ducts to comply with requirements indicated for fire-resistance-rated assembly.

3.04 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections:
 1. Compliance of seismic design.
- B. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections and prepare test reports.
- C. Perform the following tests and inspections of completed installations of acoustical panel ceiling hangers and anchors and fasteners in successive stages. Do not proceed with installations of acoustical panel ceiling hangers for the next area until test results for previously completed installations show compliance with requirements.
 1. Extent of Each Test Area: When installation of ceiling suspension systems on each floor has reached 20 percent completion but no panels have been installed.
 - a. Within each test area, testing agency will select one of every 10 power-actuated fasteners and post-installed anchors used to attach hangers to concrete and will test them for 200 lbf (890 N) of tension; it will also select one of every two post-installed anchors used to attach bracing wires to concrete and will test them for 440 lbf (1957 N) of tension.
 - b. When testing discovers fasteners and anchors that do not comply with requirements, testing agency will test those anchors not previously tested until 20 pass consecutively and then will resume initial testing frequency.

- D. Acoustical panel ceiling hangers and anchors and fasteners will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports.

3.05 CLEANING

- A. Clean exposed surfaces of acoustical panel ceilings, including trim, edge moldings, and suspension-system members. Comply with manufacturer's written instructions for cleaning and touchup of minor finish damage. Remove and replace ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

END OF SECTION 09 51 13

SECTION 09 65 13
RESILIENT BASE AND ACCESSORIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. SUMMARY OF WORK: Section 01 11 00:
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) Requirements

1.02 SUMMARY

- A. Section Includes:
 - 1. Resilient base.
 - 2. Resilient molding accessories.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Material Samples for Initial Selection: Manufacturer’s standard size for each type of product indicated.
- C. Product Schedule: For resilient base and accessory products. Use same designations indicated on the Plans.

1.04 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Furnish not less than 10 linear feet for every 500 linear feet or fraction thereof, of each type, color, pattern, and size of resilient product installed.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Store resilient products and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F or more than 90 deg F.

1.06 FIELD CONDITIONS

- A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F or more than 95 deg F, in spaces to receive resilient products during the following time periods:

1. 48 hours before installation.
 2. During installation.
 3. 48 hours after installation.
- B. After installation and until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F or more than 95 deg F.
- C. Install resilient products after other finishing operations, including painting, have been completed.

PART 2 - PRODUCTS

2.01 BASIS OF DESIGN

- A. Provide products from the following:
1. Johnsonite, Inc., or approved equal.

2.02 PERFORMANCE REQUIREMENTS

- A. FloorScore Compliance: Resilient base and stair accessories shall comply with requirements of FloorScore certification.
- B. ADA compliant transition accessories

2.03 VINYL BASE

- A. Manufacturer: As indicated on drawings.
- B. Product Standard: ASTM F 1861, Type TV (vinyl, thermoplastic).
1. Group: I (solid, homogeneous).
 2. Style: Coved Toe
- C. Minimum Thickness: 0.125 inch.
- D. Height: 2.5 inches.
- E. Lengths: 120-foot long coils.
- F. Outside Corners: Preformed.
- G. Inside Corners: Preformed.
- H. Color: As selected by Architect from manufacturer's full range.

2.04 VINYL TRANSITION MOLDING ACCESSORY

- A. Vinyl Carpet (CPT) to Concrete Slab Transition strip.

1. Basis-of-Design: Johnsonite, Inc.
2. Product: CTA-XX-J.
3. Color: As selected by Architect from manufacturer's full range.

2.05 INSTALLATION MATERIALS

- A. Trowelable Leveling and Patching Compounds: Latex-modified, Portland cement based or blended hydraulic-cement-based formulation provided or approved by resilient-product manufacturer for applications indicated.
- B. Adhesives: Water-resistant type recommended by resilient-product manufacturer for resilient products and substrate conditions indicated.
 1. Adhesives shall have VOC content of 50 g/L or less except that adhesive for rubber stair treads shall have VOC content of 60 g/L or less.
- C. Metal Edge Strips: Extruded aluminum with mill finish of width shown, of height required to protect exposed edges of flooring, and in maximum available lengths to minimize running joints. As indicated on drawings.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
 1. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of resilient products.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
 1. Installation of resilient products indicates acceptance of surfaces and conditions.

3.02 PREPARATION

- A. Prepare substrates according to manufacturer's written instructions to ensure adhesion of resilient products.
- B. Concrete Substrates for Resilient Stair Accessories: Prepare horizontal surfaces according to ASTM F 710.
 1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
 2. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by manufacturer. Do not use solvents.

3. Alkalinity and Adhesion Testing: Perform tests recommended by manufacturer. Proceed with installation only after substrate alkalinity falls within range on pH scale recommended by manufacturer in writing, but not less than 5 or more than 10 pH.
4. Moisture Testing: Proceed with installation only after substrates pass testing according to manufacturer's written recommendations, but not less stringent than the following:
 - a. Perform anhydrous calcium chloride test according to ASTM F 1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. in 24 hours.
 - b. Perform relative humidity test using in situ probes according to ASTM F 2170. Proceed with installation only after substrates have maximum 75 percent relative humidity level.
- C. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.
- D. Do not install resilient products until they are the same temperature as the space where they are to be installed.
 1. At least 48 hours in advance of installation, move resilient products and installation materials into spaces where they will be installed.
- E. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient products.

3.03 RESILIENT BASE INSTALLATION

- A. Comply with manufacturer's written instructions for installing resilient base.
- B. Apply resilient base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required.
- C. Install resilient base in lengths as long as practical without gaps at seams and with tops of adjacent pieces aligned.
- D. Tightly adhere resilient base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.
- E. Do not stretch resilient base during installation.
- F. On masonry surfaces or other similar irregular substrates, fill voids along top edge of resilient base with manufacturer's recommended adhesive filler material.
- G. Preformed Corners: Install preformed corners before installing straight pieces.
- H. Job-Formed Corners:
 1. Outside Corners: Use straight pieces of maximum lengths possible and form with

returns not less than 3 inches in length.

a. Form without producing discoloration (whitening) at bends.

2. Inside Corners: Use straight pieces of maximum lengths possible and form with returns not less than 3 inches in length.

a. Miter corners to minimize open joints.

3.04 RESILIENT ACCESSORY INSTALLATION

A. Comply with manufacturer's written instructions for installing resilient accessories.

B. Resilient Molding Accessories: Butt to adjacent materials and tightly adhere to substrates throughout length of each piece. Install reducer strips at edges of floor covering that would otherwise be exposed.

3.05 CLEANING AND PROTECTION

A. Comply with manufacturer's written instructions for cleaning and protecting resilient products.

B. Perform the following operations immediately after completing resilient-product installation:

1. Remove adhesive and other blemishes from exposed surfaces.

2. Sweep and vacuum horizontal surfaces thoroughly.

3. Damp-mop horizontal surfaces to remove marks and soil.

C. Protect resilient products from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.

D. Cover resilient products subject to wear and foot traffic until Substantial Completion.

END OF SECTION 09 65 13

SECTION 09 68 13
TILE CARPETING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. SUMMARY OF WORK: Section 01 11 00:
 - 1. Refer to "PART 2 – PRODUCTS" for all Buy America Build America Act (BABA) Requirements

1.02 SUMMARY

- A. Section includes modular, multi-level pattern loop carpet tile and multi-level pattern cut/loop carpet tile.

1.03 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
 - 1. Review methods and procedures related to carpet tile installation including, but not limited to, the following:
 - a. Review delivery, storage, and handling procedures.
 - b. Review ambient conditions and ventilation procedures.
 - c. Review subfloor preparation procedures.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include manufacturer's written data on physical characteristics, durability, and fade resistance.
 - 2. Include installation recommendations for each type of substrate.
- B. Shop Drawings: Show the following:
 - 1. Columns, doorways, enclose walls or partitions, built-in cabinets, and locations where cutouts are required in carpet tiles.
 - 2. Carpet tile type, color, and dye lot.
 - 3. Type of subfloor.
 - 4. Type of installation.

5. Pattern of installation.
 6. Pattern type, location, and direction.
 7. Pile direction.
 8. Type, color, and location of insets and borders.
 9. Type, color, and location of edge, transition, and other accessory strips.
 10. Transition details to other flooring materials.
- C. Samples: For each of the following products and for each color and texture required. Label each Sample with manufacturer's name, material description, color, pattern, and designation indicated on Drawings and in schedules.
1. Material: Manufacturer's full range in five (5) varying carpet tile product types by single manufacturer for selection by Architect
 - a. Up to three (3) different carpet tile product types
 2. Carpet Tile: Full-size Sample of each as selected by Architect.
- D. Product Schedule: For carpet tile. Use same designations indicated on Drawings.

1.05 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Product Test Reports: For carpet tile, for tests performed by a qualified testing agency.
- C. Sample Warranty: For special warranty.

1.06 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For carpet tiles to include in maintenance manuals. Include the following:
 1. Methods for maintaining carpet tile, including cleaning and stain-removal products and procedures and manufacturer's recommended maintenance schedule.
 2. Precautions for cleaning materials and methods that could be detrimental to carpet tile.

1.07 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Carpet Tile: Full-size units equal to 5 percent of amount installed for each type selected, but not less than 10 sq. yd.

1.08 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who is certified by the International Certified Floorcovering Installers Association at the Commercial II certification level.
- B. Fire-Test-Response Ratings: Where indicated, provide carpet tile identical to those of assemblies tested for fire response according to NFPA 253 by a qualified testing agency.

1.09 DELIVERY, STORAGE, AND HANDLING

- A. Comply with CRI 104.

1.10 FIELD CONDITIONS

- A. Comply with CRI 104 for temperature, humidity, and ventilation limitations.
- B. Environmental Limitations: Do not deliver or install carpet tiles until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and ambient temperature and humidity conditions are maintained at occupancy levels during the remainder of the construction period.
- C. Do not install carpet tiles over concrete slabs until slabs have cured and are sufficiently dry to bond with adhesive and concrete slabs have pH range recommended by carpet tile manufacturer.
- D. Where demountable partitions or other items are indicated for installation on top of carpet tiles, install carpet tiles before installing these items.

1.11 WARRANTY

- A. Special Warranty for Carpet Tiles: Manufacturer agrees to repair or replace components of carpet tile installation that fail in materials or workmanship within specified warranty period.
 - 1. Warranty does not include deterioration or failure of carpet tile due to unusual traffic, failure of substrate, vandalism, or abuse.
 - 2. Failures include, but are not limited to, more than 10 percent edge raveling, snags, runs, dimensional stability, excess static discharge, loss of tuft bind strength, loss of face fiber, and delamination.
 - 3. Warranty Period: 10 years from date of Final Acceptance.

PART 2 - PRODUCTSCARPET TILE

- A. Basis of Design (BOD): Shaw Contract Group, Inc., or approved equal
 - 1. Fiber Content: 100 percent nylon 6.
 - 2. Fiber type: "Eco Solution "Q" Nylon.
 - 3. Pile Characteristic: Multi-level pattern loop and multi-level pattern cut loop pile.

4. Density: 5058 (9.42 kilotex).
5. Pile Thickness: For finished carpet tile according to ASTM D6859: 0.121 (3.07 mm)
6. Stitches: stitches per inch (mm):9.0
7. Gage: ends per inch (mm): 1/12 (6.5 mm)
8. Installation method: As selected by Architect.
9. Colors and Types: As selected by Architect
10. Primary backing/Back coating: Synthetic, manufacturer's standard composite materials.
11. Secondary Backing: "Ecoworx Tile", manufacturer's standard material.
12. Size: 24 by 24 inches (610 by 610 mm).
13. Applied Soil-Resistance Treatment: 'SSP Shaw Soil Treatment, manufacturer's standard material.

2.02 INSTALLATION ACCESSORIES

- A. Trowelable Leveling and Patching Compounds: Latex-modified, hydraulic-cement-based formulation provided or recommended by carpet tile manufacturer.
- B. Adhesives: Water-resistant, mildew-resistant, non-staining, pressure-sensitive type to suit products and subfloor conditions indicated, that complies with flammability requirements for installed carpet tile and is recommended by carpet tile manufacturer for releasable installation.
 1. Adhesives shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 2. Adhesives shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- C. Vinyl Edge/Transition Strips: Of height required to protect exposed edge of carpet, with maximum lengths to minimize running joints, and as indicated on the Plans.

PART 3 - EXECUTION EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for maximum moisture content, alkalinity range, installation tolerances, and other conditions affecting carpet tile performance. Examine carpet tile for type, color, pattern, and potential defects.
- B. Concrete Subfloors: Verify that concrete slabs comply with ASTM F 710 and the

following:

1. Slab substrates are dry and free of curing compounds, sealers, hardeners, and other materials that may interfere with adhesive bond. Determine adhesion and dryness characteristics by performing bond and moisture tests recommended by carpet tile manufacturer.
 2. Subfloor finishes comply with requirements specified in Section 03 30 00 "Cast-in-Place Concrete" for slabs receiving carpet tile.
 3. Subfloors are free of cracks, ridges, depressions, scale, and foreign deposits.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. General: Comply with CRI 104, Section 6.2, "Site Conditions; Floor Preparation," and with carpet tile manufacturer's written installation instructions for preparing substrates indicated to receive carpet tile installation.
- B. Use trowelable leveling and patching compounds, according to manufacturer's written instructions, to fill cracks, holes, depressions, and protrusions in substrates. Fill or level cracks, holes and depressions 1/8 inch (3 mm) wide or wider and protrusions more than 1/32 inch (0.8 mm) unless more stringent requirements are required by manufacturer's written instructions.
- C. Remove coatings, including curing compounds, and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, without using solvents. Use mechanical methods recommended in writing by carpet tile manufacturer.
- D. Clean metal substrates of grease, oil, soil and rust, and prime if directed by adhesive manufacturer. Rough sand painted metal surfaces and remove loose paint. Sand aluminum surfaces, to remove metal oxides, immediately before applying adhesive.
- E. Broom and vacuum clean substrates to be covered immediately before installing carpet tile.

3.03 INSTALLATION

- A. General: Comply with CRI 104, Section 14, "Carpet Modules," and with carpet tile manufacturer's written installation instructions.
- B. Maintain dye lot integrity. Do not mix dye lots in same area.
- C. Cut and fit carpet tile to butt tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, edgings, thresholds, and nosings. Bind or seal cut edges as recommended by carpet tile manufacturer.
- D. Extend carpet tile into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.
- E. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on finish flooring as marked on subfloor. Use nonpermanent, non-

staining marking device.

- F. Install pattern parallel to walls and borders.
- G. Stagger joints of carpet tiles so carpet tile grid is offset from access flooring panel grid. Do not fill seams of access flooring panels with carpet adhesive; keep seams free of adhesive.

3.04 CLEANING AND PROTECTION

- A. Perform the following operations immediately after installing carpet tile:
 - 1. Remove excess adhesive, seam sealer, and other surface blemishes using cleaner recommended by carpet tile manufacturer.
 - 2. Remove yarns that protrude from carpet tile surface.
 - 3. Vacuum carpet tile using commercial machine with face-beater element.
- B. Protect installed carpet tile to comply with CRI 104, Section 16, "Protecting Indoor Installations."
- C. Protect carpet tile against damage from construction operations and placement of equipment and fixtures during the remainder of construction period. Use protection methods indicated or recommended in writing by carpet tile manufacturer.

END OF SECTION 09 68 13

SECTION 09 69 00
ACCESS FLOORING

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Access flooring is to consist of a series of modular, removable, interchangeable panels on an elevated support system forming an accessible underfloor cavity to accommodate electrical and mechanical services. System is to be gravity-held panels on bolted stringer understructure.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00:
 - 1. Refer to "PART 2 – PRODUCTS" for all Buy America Build America Act (BABA) Requirements

1.03 DESIGN CRITERIA

- A. Structural Performance per CISCA A/F: Provide access flooring systems capable of withstanding the following loads and stresses within limits and under conditions indicated, as determined by testing manufacturer's current standard products according to referenced procedures in CISCA:
 - 1. Ultimate-Load Performance: Provide access flooring systems capable of withstanding a minimum ultimate concentrated load equal to value obtained by multiplying specified concentrated floor panel design load by a factor of 2.5, without failing, according to CISCA A/F, Section II, "Ultimate Loading." Failure is defined as the point at which access flooring system will not take any additional load.
- B. Pedestal Assembly:
 - 1. Pedestal Axial-Load Performance: Provide pedestal assemblies, without panels or other supports in place, capable of withstanding a 22 kN (5000 pound force) axial load per pedestal, according to CISCA A/F, Section V, "Pedestal Axial Load Test."
 - 2. Pedestal Overturning-Moment Performance: Provide pedestal assemblies, without panels or other supports in place, capable of withstanding an overturning moment per pedestal of 113 N x meters (1000 pound force x inches), according to CISCA A/F, Section VI, "Pedestal Overturning Moment Test."
 - 3. Provide a means of leveling and locking the assembly at a selected height which requires deliberate action to change height setting and which prevents vibrating displacement.
- C. Stringer:

1. Stringer Concentrated-Load Performance: Provide stringers, without panels in place, capable of withstanding a concentrated load of 890 N (200 pound force) at center of span with a permanent set not to exceed 0.25 mm (0.010 inch), as determined per CISCA A/F, Section IV, "Stringer Load Testing."
- D. Panels:
1. All panels are to be interchangeable except those altered to meet special conditions.
 2. Floor Panel Impact-Load Performance: Provide access flooring system capable of withstanding an impact load of 334 N (75 pound force) when dropped from 914 mm (36 inches) onto a 6.5-square cm (1-square inch) area located anywhere on the panel, without failing. Failure is defined as collapse of access flooring system.
- E. Installed access floor is to be level within plus or minus 1.59 mm in 3.05 m (1/16 inch in 10 feet), and plus or minus 3.18 mm (1/8 inch) over the entire area. Floor assembly to be rigid, free of vibration, rocking panels, rattles and squeaks.
- F. Flame Spread Rating: Provide assembly flame spread of 25 or less using ASTM E84 test method.

1.04 SUBMITTALS

- A. Submit in accordance with Section 01 33 00
- B. Samples
- C. Shop Drawings:
 1. Floor panel layout, including railing, step and ramp location.
 2. Detail components of assembly, anchoring methods and edge details, including cut-out details, method of grounding.
- D. Manufacturer's Literature and Data: Access floor.
- E. Manufacturer's Certificates: Flame spread rating.
- F. Floor System Test Reports: Submit certified test reports, from a testing laboratory satisfactory to the COR, attesting that the floor system proposed for installation meets all specified requirements. Submit test reports with shop drawings.
- G. Manufacturer's Qualifications.
- H. Installer's Qualifications.

1.05 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Manufacturer with three (3) years' experience in providing items of type specified.

- B. Installer's Qualifications: Installers who are trained and approved by manufacturer and have a minimum of three (3) years' experience installation of units required for this project.
- C. Obtain access flooring from single manufacturer.

1.06 DELIVERY, STORAGE AND HANDLING

- A. Delivery:
 - 1. Deliver materials to site in undamaged condition, in original containers or packages, complete with accessories and instructions. Label packages with manufacturer's name and brand designations. Package materials covered by specific references bearing specification number, type, and class as applicable.
- B. Storage:
 - 1. Store all materials in original protective packaging in a safe, dry, and clean location. Store panels at temperatures between 4 and 32 degrees C (40 and 90 degrees F) and between 20 and 70 percent humidity. Replace defective or damaged materials.
- C. Handling:
 - 1. Handle and protect materials in a manner to prevent damage during the entire construction period.

1.07 WARRANTY

- A. Comply with Owner warranty requirements.

1.08 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. National Association of Architectural Metal Manufacturers (NAAMM)
- C. National Electrical Manufacturers Association (NEMA)
- D. Underwriters Laboratory (UL)

PART 2 - PRODUCTS

2.01 FLOOR COVERING

- A. High Pressure Laminate

2.02 FLOOR PANELS

- A. Construct panels to be uniform in face dimensions, within a tolerance of plus or minus 0.38 mm (0.015 inches) of required size and be square within a tolerance of plus or minus

0.38 mm (0.015 inches), and flatness within a tolerance of plus or minus 0.5 mm (0.02 inches). Design individual floor panels to be easily placed and removed, without disturbing adjacent panels or understructure, by one (1) person using a tool furnished by the access floor manufacturer. Provide panels 610 by 610 mm (24 by 24 inches).

B. Filled Formed-Steel Panels:

1. Cementitious-filled panels fabricated with die-cut flat top sheet and die-formed and stiffened bottom pan formed from cold-rolled steel sheet joined together by resistance welding to form an enclosed assembly, with metal surfaces protected against corrosion by manufacturer's standard factory-applied finish.

2.03 CUT-OUTS

- A. Fabricate cut-outs in floor panels to accommodate cable penetrations and service outlets where shown on construction documents or specified. Provide reinforcement or additional support to make panels with cut-outs perform the same as solid uncut panels. Fit cut-outs with manufacturer's standard grommet. For cut-outs larger than maximum size grommet, trim edge of cut-outs with plastic trim, molding and/or gaskets having tapered top flange. Provide removable twist close covers for grommets.

2.04 ACCESSORIES

- A. Perimeter Support: Where indicated on construction documents, provide manufacturer's standard method for supporting panel edge and form transition between access flooring and adjoining floor covering at same level as access flooring.
- B. Floor Cleaner: Type recommended by the floor covering manufacturer.

2.05 PEDESTALS

- A. Provide manufacturer's standard pedestal assembly including base, column with provisions for adjustment, locking device, head and pad.
1. Base: Provide pedestal base with not less than 101 by 101 mm (4 by 4 inches) of bearing area.
 2. Column: Hollow shaft of appropriate length fitted with threaded rod and leveling nut.
 3. Provide vibration proof mechanism for making and holding fine adjustments in heights for leveling purposes over a range of not less than 50 mm (2 inches). Include means of locking mechanism at a selected height.
 4. Heads: Provide heads designed to accommodate bolted stringers to hold panels in place in a freestanding stringer-less understructure.
 5. Pads: Provide sound dampening pad for each pedestal head.
 6. Fabricate units of sufficient height to provide required under floor clearance indicated in construction documents.

2.06 STRINGERS

- A. Form stringers from extruded aluminum or zinc coated steel in 610 mm (2 foot) lengths. Attach stringers to pedestals with threaded fasteners accessible from above. Stringer system to form a grid pattern with members under edges of floor panels and with pedestals under adjacent panel corners.

2.07 FINISHES

- A. General: Apply finishes in factory after products are fabricated. Protect finishes on exposed surfaces with protective covering before shipment.
- B. Aluminum Finishes:
 - 1. In accordance with NAAMM AMP 500 series:
 - 2. Clear anodized finish: AA-C22A41 Chemically etched medium matte, clear anodic coating, Class I Architectural, 0.018 mm (0.7-mil) thick.
 - 3. Factory-Primed Concealed Surface: Protect concealed aluminum surfaces that will be in contact with plaster, concrete or masonry surfaces when installed by applying a shop coat of zinc-molybdate primer to contact surfaces. Provide minimum dry film thickness of 0.05 mm (2.0 mils).

PART 3 - EXECUTION

3.01 PREPARATION

- A. Install floor sealer, required for dust or vapor control, prior to installation of pedestals, only if the pedestal adhesive will not damage the coating. If the coating and adhesive are not compatible, apply the coating after the pedestals have been installed and the adhesive has cured.
- B. Prior to installation, subfloor is to be dry and free of any surface irregularities that will adversely affect access flooring system appearance or performance.
- C. Clear the area in which the floor system is to be installed of debris. Clean floor surfaces and remove dust before the work is started.

3.02 INSTALLATION

- A. Layout floor panel installation to keep the number of cut panels at the floor perimeter to a minimum and to sizes not less than 1/2 half width to the greatest extent possible. Scribe panel assemblies at perimeter and around column to provide a close fit with no voids greater than 6 mm (1/4 inch) where panels abut vertical surface.
- B. Secure bases of pedestals to the structural sub-base with mechanical fasteners in full and firm contact with the subbase. Set pedestals plumb, and in true alignment.
- C. Where pedestal stringer system is used, join the stringers and other framing members with threaded fasteners for positive connection to the pedestals to preclude lateral movement. Uniformly space stringers in parallel lines, and place at the indicated

elevation.

- D. Provide auxiliary framing around columns and other permanent construction, at sides of ramps, at free ends of floor, and beneath floor panels that are substantially cut to accommodate utility systems.
- E. Construct floor panels to lie flat without warp or twist and bear uniformly on supports without rocking, and without edges projecting above the floor plane. Panels to interlock with supports in a manner that will preclude lateral movement.
- F. Provide free ends of floor with positive anchorage and rigid support where floor system does not abut wall or other construction.
- G. Cover exposed ends of floor system with aluminum closures. Closures to consist of complete trim and fascia assemblies.

3.03 REPAIR OR WELDED GALVANIZED SURFACES:

- A. Use galvanized repair compound where galvanized surfaces are scheduled to receive field or shop coatings, and apply in accordance with manufacturers printed instructions.

3.04 CLEANING

- A. Remove debris accumulated during installation from beneath the raised floor system. Immediately after completion of the floor installation, apply floor cleaner in accordance with the floor covering manufacturer's instruction. Do not allow any cleaner to remain between individual panels.

3.05 PROTECTION

- A. Cover cleaned floors with clean building paper before construction traffic is permitted. Remove protective covering at completion of Work.

END OF SECTION 09 69 00

SECTION 09 84 00
FREEFORM BAFFLE SOUND-ABSORBING WALL AND CEILING UNITS

PART 1 - GENERAL

A. SUMMARY

1. Section Includes.
 - a. Acoustical Ceiling Baffles.

1.02 RELATED WORK

A. SUMMARY OF WORK: Section 01 11 00:

1. Refer to "PART 2 – PRODUCTS" for all Buy America Build America Act (BABA) Requirements

B. HVAC AIR DISTRIBUTION: Divisions 23.

C. ELECTRICAL: Division 26.

D. PAINTING: Section 09 90 00

E. GYPSUM BOARD: Section 09 29 00

1.03 REFERENCES

A. American Society for Testing and Materials (ASTM):

1. ASTM C 423 Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
2. ASTM E 84 Standard Test Method for Surface Burning Characteristics of Building Materials.
3. ASTM E795 - Standard Practices for Mounting Test Specimens During Sound Absorption Tests; 2016.

1.04 SUBMITTALS

A. General: Submit manufacturer's documentation for each type of product under provisions of Section 01 30 30 - Administrative Requirements, for submittal procedures.

B. Product Data: Manufacturer's printed data sheets for products specified.

C. Shop Drawings: Fabrication and installation details, panel layout.

D. Selection Samples: Manufacturer's color charts for applicable material, indicating full range of material, colors, and patterns available.

E. Verification Samples: Fabricated samples of each type of product specified; 6" minimum

length and width, showing construction, edge details.

- F. Test Reports: Certified test data from an independent test agency verifying that panels meet specified requirements for acoustical and fire performance.
- G. Maintenance Materials: Furnish maintenance information and recommendations for Owner's use.

1.05 QUALITY ASSURANCE

- A. Single-Source Responsibility: Provide acoustical panel units and grid components by a single manufacturer.
- B. Fire Performance Characteristics: Identify acoustical ceiling components with appropriate UL markings.
- C. Surface Burning Characteristics: Tested per ASTM E 84 (face material and furring) and complying with ASTM E 1264 Classification.
- D. Coordination of Work: Coordinate acoustical ceiling work with installers of related work including, but not limited to building insulation, gypsum board, light fixtures, mechanical systems, electrical systems, and sprinklers.
- E. Installer Qualifications: Utilization of an installer with demonstrated experience and quality in projects of similar size and complexity.

1.06 DELIVERY, STORAGE AND HANDLING

- A. Protect acoustical units from moisture during shipment, storage, and handling. Deliver in factory-wrapped bundles; do not open bundles until units are needed for installation. Ensure all supplied hardware, material, and components are maintained until product is fully installed.
- B. Store units flat, in dry, well-ventilated space; do not stand on end.
- C. Protect edges from damage.
- D. Acclimatize product for minimum 24 hours at temperature and humidity approximately that of occupancy prior to installation.

1.07 PROJECT / SITE CONDITIONS

- A. Environmental Limitations: Do not deliver or install materials until spaces are enclosed from the exterior environment, wet work in spaces is complete and dry, and HVAC system is maintaining an ambient temperature at occupancy levels during the remainder of the construction period.
- B. Field Measurements: Installer to verify field measurements and dimensions as indicated in Design Submittal.
 - 1. Coordinate location of other product and trades with product layout.

- C. Ensure that Design Submittal signoffs and other required information are supplied in time to prevent interruption of construction process. Ensure that products of this section are supplied to affected trades in time to prevent interruptions.

1.08 WARRANTY

- A. Special Warranty: Refer to manufacturer's standard warranty for specific products, terms, and limitations.
- B. The Warranty shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and will be in addition to and run concurrent with other warranties made by the Contractor under the requirements of the Contract Documents.

PART 2 - PRODUCTS

2.01 MANUFACTURER

- A. Basis of Design: TURF; Located at 2000 Fox Ln. Elgin, Illinois, 60123; Phone: 844.TURF.OMG (844.887.3664); Email: hello@turf.design; Web: www.turf.design

2.02 SOUND-ABSORBING AND SOUND DIFFUSING PANELS

- A. Basis of Design: Turf Design; Product: 'FREEFORM BAFFLE' <https://turf.design/>
- B. Material Minimum Performance Attributes:
 - 1. Surface Burning Characteristics: Flame spread index of 25 or less and smoke developed index of 450 or less, when tested in accordance with ASTM E84.
 - 2. UL Tested ASTM E-84: Class A
 - a. Noise Reduction Coefficient (NRC):
 - 3. Material tested in accordance with ASTM C423 for Type J ceiling mounting, per ASTM E795. Avg. apparent NRC > 0.75 or greater.
- C. Product Attributes:
 - 1. Baffle Size: As indicated in Submittal Drawings.
 - 2. Max depth by up to 119"L. provide continuous clip at intersecting baffles.
 - 3. Baffle Thickness: 2.25"W typical.
 - 4. Edges: Exposed felt, machined edge.
 - 5. Corners: Square, exposed felt, machined edge.
 - 6. Material: Polyester (PET) felt, 60% pre-consumer recycled.
 - 7. Color: As selected by Architect from manufacturer's full range.

8. Patterns: As selected by Architect from manufacturer's full range and outlined in Submittal Drawings.
9. Mounting Method: Horizontally suspended from ceiling.
10. Suspended with 3/64" steel aircraft cable, inserted into integral spring clips, supplied by manufacturer, with integrated threaded rod post.

2.03 FABRICATION

- A. General: CNC fabricate panels to sizes, configurations and patterns on 9 mm PET felt with 3 mm PET felt facing. Factory installed hardware.
- B. Tolerances: Fabricate to finished tolerance of plus or minus 1/16 inch for thickness, overall length and width, and square-ness from corner to corner.

2.04 ACCESSORIES

- A. Ceiling-Suspended Accessories: Manufacturer's standard accessories at locations indicated on each acoustical unit, sized appropriately for weight of acoustical unit.
 1. Contractor to select and provide all anchors to building for mounting based on site requirements, conditions, and as appropriate for application.
 2. Provide ceiling mounting points for cable suspension from ceilings.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates for conditions detrimental to installation of acoustical units. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Install acoustical units in locations indicated, following manufacturer's installation instructions and in accordance with local jurisdiction authorities.
- B. Align panels accurately, with edges plumb and top edges level. Trim baffle blade in field as required for obstructions maintaining stiffener integrity and 2 connection points.
- C. Install acoustical units to construction tolerances of plus or minus 1/16 inch for the following:
 1. Plumb and level.
 2. Flatness.
 3. Width of joints.

3.03 ADJUSTING AND CLEANING

- A. Replace damaged and broken Turf Freeform Panels.
- B. Clean exposed surfaces of acoustical ceilings including trim, edge moldings, and suspension members. Comply with manufacturer's instructions for cleaning and touch up of minor finish damage. Remove any Freeform Ceiling/Wall Panels that cannot be successfully cleaned and/or repaired. Replace with attic stock or new product to eliminate evidence of damage.

3.04 PROTECTION

- A. Provide protection of installed acoustical panels until completion of the work.
- B. Replace panels that cannot be cleaned and repaired to satisfaction of the Architect.

END OF SECTION 09 84 00

SECTION 09 91 00
PAINTING

PART 1 - GENERAL

1.01 DESCRIPTION

- A. This Section includes:
 - 1. Surface preparation and application of painting and related work in locations indicated on the Plans and specified herein.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00:
 - 1. Refer to "PART 2 – PRODUCTS" for all Buy America Build America Act (BABA) Requirements
- B. JOINT SEALANTS: Section 07 92 00.
- C. HOLLOW METAL DOORS AND FRAMES: Section 08 11 13.

1.03 QUALITY ASSURANCE

- A. All surfaces of fabricated items that are left unfinished by the requirements of other sections shall be painted under this Section. All work specified in this Section shall be in addition to shop and mill coats, priming and field coats which are specified in other sections.
- B. Perform all touching up of shop coats and field coats of paint on structural steel and miscellaneous steel or iron as required and/or specified.
- C. Aluminum, steel, stainless steel, copper, bronze, chromium plating, nickel, monel metal, lead, lead coated copper and other surfaces with factory finishes shall not be painted or finished, except as otherwise specified.
- D. Remove and re-finish or otherwise correct in a manner approved by Engineer all work under this Section which peels, crazes, blisters, fails to adhere or otherwise fails to properly serve its intended purpose at no additional cost to the Owner.

1.04 PRODUCT DELIVERY AND STORAGE

- A. All materials shall be delivered to the Site in manufacturers' sealed packages, with labels intact.

1.05 SUBMITTALS

- A. Product Data: Submit manufacturer's product data for each type of product used.
- B. Samples: Submit three (3) sets of full color chip line for each type of paint specified, for color selection(s) by the Engineer.

- C. Draw Downs: Provide three (3) stepped draw downs, defining each separate coat, including block fillers and primers, for each color and material to be applied. Use representative colors when preparing draw down for review.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Basis of Design manufacturer/product is shown on the Plans.
- B. Conform to the coating specifications and standards referenced herein under PART 3.9 – PAINTING SCHEDULE.
- C. MPI System numbering system herein specified is found in either the MPI Architectural Painting Specification Manual or the Maintenance Repainting Manual and defined as an EXTERIOR or INTERIOR system.
- D. All ready-mixed paints shall be first-line (best quality grade) retail products. The use of lead-containing paint is NOT permitted.
- E. Thinners and additives shall be of types recommended by the paint manufacturer.
- F. Coating system for exposed structural steel shall meet the performance requirements of OWNER Standard Specification 975.

PART 3 - EXECUTION

3.01 INSPECTION

- A. Examine the areas and conditions under which painting is to be applied. Do not proceed with painting work until unsatisfactory conditions have been corrected.

3.02 COLORS

- A. The Engineer will select all colors and provide a schedule of colors and finishes.
- B. Each coat of paint shall be applied in varying shades, with the final coat matching the approved color selected.

3.03 PREPARATION FOR PAINTING

- A. Surfaces to be painted shall be clean, smooth, free from scratches and dust and thoroughly dry. Wood surfaces shall be well sanded before painting work is started.
- B. Concrete surfaces shall be cleaned, grouted, rubbed and pointed, water flushed clean and free of all dust, oily grease and laitance, and allowed to dry prior to painting.
- C. Steel and iron shall be free from grease, rust, scale and dust. Touch up any chipped or abraded places on items that have been shop coated. Where steel and iron have heavy coating of scale, it shall be removed by wire brush or sand blasting necessary to produce a satisfactory surface for painting.

3.04 PROTECTION

- A. Adjacent fixtures and hardware shall be removed during the painting application.
- B. Particular care shall be taken by the use of clean drop cloths, masking and other suitable means, to protect adjoining surfaces, fixtures, and materials of all kinds. Painting applicator shall be held responsible for, and shall repair, all damages resulting from the painting operation.
- C. All ceiling and soffit overhead painting shall be applied only while the floor is completely and continuously covered with drop cloths.

3.05 APPLICATION

- A. Paints shall be applied in the colors and minimum number of coats scheduled herein and at the square foot coverage as stated in the paint manufacturer's printed specifications. It is intended that paint so applied shall cover to the satisfaction of the Engineer or additional coats shall be applied until approval is obtained.
- B. Paints shall not be applied to surfaces which show a moisture content greater than 15 percent as determined by an electronic moisture meter.
- C. Paints shall not be applied when the temperature falls below 45 degrees F., in damp, rainy weather, or when the relative humidity exceeds 85 percent.
- D. Paint shall be evenly spread and well distributed. The finish coats shall be free from any noticeable laps, brush marks, streaks, runs, sags, wrinkles, and shiners.
- E. All wood surfaces shall be thoroughly sanded between coats as required for a flaw-free finish.

3.06 BACK PRIMING

- A. All wood surfaces (except pressure treated wood) to be placed against concrete or masonry substrates shall be painted with a sealer coat of paint or clear varnish before installation

3.07 TOUCH UP AND CLEANING

- A. Upon completion, all touching-up as required shall be applied and any paint shall be removed from all surfaces which are not specified to receive paint.

3.08 PAINTING OF PIPING FOR IDENTIFICATION

- A. Exposed piping, piping concealed in accessible pipe spaces and piping behind access panels shall be identified to designate service.
- B. Legend shall be stencil applied (painted on) at 40 feet spacing on straight runs where pipes pass through walls or floors and regulators, strainers, and clean-outs (except valves and fittings on plumbing fixtures and equipment).
- C. Legend shall give name in full or abbreviations. Size of stenciled identity lettering shall vary with the diameter of pipe covering as follows:

1. Up to 1": 1/2" high letters.
2. Over 1": 3/4" high letters.

3.09 3.09 PAINTING SCHEDULE

A. The following surfaces shall be finished with the designated number of coats (in addition to shop or manufacturer's coats) with a Dry Film Thickness (DFT) of not less than indicated:

B. Omit primer on items with shop coat primer. All shop coats shall be touched up with the same kind of paint as the shop coat and allowed to dry before application of finish coats.

C. **EXTERIOR**

1. Metal, Galvanized: MPI EXT 5.3J-G5 – Waterborne Light Industrial - Semi-Gloss Finish.

Primer	MPI 134	SW - PROCYL PRIMER
Intermediate	MPI 163	SW - ALL SURFACE ENAMEL
Topcoat	MPI 163	SW - ALL SURFACE ENAMERL (SEMI-GLOSS)

2. Metal, Ferrous: MPI EXT 5.1Q-G5 – Alkyd - Semi-Gloss Finish.

Primer	MPI 23	SW - KEM KROMIK PRIMER
Intermediate	MPI 94	SW - DIRECT TO METAL ALKYD
Topcoat	MPI 94	SW - DIRECT TO METAL ALKYD (SEMI-GLOSS)
System DTF: 5.25 mils.		

3. Stucco: MPI EXT - 4.2G – Epoxy System - Semi - Gloss Finish

Primer	MPI 23	SW - KEM CATI-COAT HS EPOXY FILLER
Topcoat	MPI 94	SW - DIRECT TO METAL ALKYD (SEMI-GLOSS)
System DTF: 5.25 mils.		

INTERIOR

4. Metal, Galvanized: MPI INT 5.3J-G5 – Waterborne Latex - Semi-Gloss Finish.

Primer	MPI 134	SW - PRO INDUSTRIAL PRO-CYL PRIMER
Intermediate	MPI 43	SW - PRO MAR 200 HP ZERO VOC S/G
Topcoat	MPI 43	SW - PRO MAR 200 HP ZERO VOC S/G (SEMI-GLOSS)

5. Metal, Ferrous: MPI INT 5.1E-G5 – Alkyd - Semi-Gloss Finish.

Primer	MPI 79	SW - KEM KROMIK PRIMER
Intermediate	MPI 47	SW - PRO MAR 200 ALKYD S/G
Topcoat	MPI 47	SW - PRO MAR 200 ALKYD S/G (SEMI-GLOSS)

6. Piping and Conduit, Exposed Surfaces: Semi-Gloss Finish.

Ferrous Metal: MPI INT 5.4F-G3 – Alkyd.

Primer	MPI 79	SW - KEM KROMIK PRIMER
Intermediate	MPI 47	SW - DIRECT TO METAL ALKYD
Topcoat	MPI 47	SW - DIRECT TO METAL ALKYD (SEMI-GLOSS)
System DTF: 4.4 mils.		

Aluminum and Galvanized Metal: MPI INT 5.4F-G3 - High Performance Architectural Latex.

Primer	MPI 95	SW - KEM KROMIK PRIMER
Intermediate	MPI 139	SW - PRO INDUSTRIAL PRE-CATAYZED WATERBASED EPOXY
Topcoat	MPI 139	SW - PRO INDUSTRIAL PRE-CATAYZED WATERBASED EPOXY (SEMI-GLOSS)
System DTF: 5 mils.		

7. Gypsum Board Surfaces

Typical surfaces exposed to view: Match existing sheen

Primer	MPI 50	SW - QUICK DRY STAIN BLOCKING PRIMER
Intermediate	MPI 43	SW - SUPERPAINT INTERIOR LATEX
Topcoat	MPI 43	SW - SUPERPAINT INTERIOR LATEX (SEMI-GLOSS)

Wet area surfaces, including restrooms, custodial closets, and Mechanical Rooms: Semi-Gloss Finish

Primer	MPI 149	SW - PRO MAR 200 ZERO VOC INTERIOR LATEX PRIMER
Intermediate	MPI 153	SW - PRO INDUSTRIAL WATER BASED CATALYZED EPOXY
Topcoat	MPI 153	SW - PRO INDUSTRIAL WATER BASED CATALYZED EPOXY (SEMI-GLOSS)

8. Plywood: MPI INT 6.1C – Alkyd Varnish System

Primer	NA	SW - SHER-WOOD STAIN BASE
Intermediate	NA	SW - WOOD CLASSICS WATERBORNE POLYURETHANE VARNISH
Topcoat	NA	SW - WOOD CLASSICS WATERBORNE POLYURETHANE VARNISH

END OF SECTION 09 91 00

SECTION 10 14 23
ROOM IDENTIFICATION SIGNAGE

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes room-identification signs that are directly attached to the building.
- B. Related Requirements:
 - 1. Provide signs at all exterior doors.
 - 2. Sign graphics, text, and colors shall be selected by Architect.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00:
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) Requirements

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For room-identification signs.
 - 1. Include fabrication and installation details and attachments to other work.
 - 2. Show sign mounting heights, locations of supplementary supports to be provided by other installers, and accessories.
 - 3. Show message list, typestyles, graphic elements, including raised characters and Braille, and layout for each sign.
- C. Samples: Provide material samples of standard manufacturer’s full range of colors.
 - 1. Include representative Samples of available typestyles and graphic symbols.
- D. Product Schedule: For room-identification signs. Use same designations as indicated on Plans.

1.04 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer and manufacturer.

1.05 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For signs to include in maintenance manuals.

1.06 QUALITY ASSURANCE

- A. Installer Qualifications: Manufacturer of products or an entity that employs installers and supervisors who are trained and approved by manufacturer.

1.07 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of signs that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Deterioration of finishes beyond normal weathering.
 - b. Deterioration of embedded graphic image.
 - c. Separation or delamination of sheet materials and components.
 - 2. Warranty Period: Five years from date of Final Acceptance.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Accessibility Standard: Comply with applicable provisions in the USDOJ's "2010 ADA Standards for Accessible Design" and ICC A117.1.

2.02 ROOM IDENTIFICATION SIGNS

- A. Room-Identification Signs: Sign with smooth, uniform surfaces; with message and characters having uniform faces, sharp corners, and precisely formed lines and profiles.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Creative Sign Designs
 - b. ACE Sign Systems, Inc.
 - c. Advance Corporation.
 - d. Allen Industries Architectural Signage.
 - e. Allied Signage
 - f. APCO Graphics, Inc.
 - g. ASE, Inc.
 - h. ASI Sign Systems, Inc.
 - i. Best Sign Systems, Inc.

- j. Clarke Systems.
 - k. Diskey Architectural Signage Inc.
 - l. Mohawk Sign Systems.
 - m. Or approved equal.
2. Laminated-Sheet Sign: Photopolymer or sandblasted polymer face sheet with raised graphics laminated over subsurface graphics to acrylic backing sheet to produce composite sheet.
 - a. Composite-Sheet Thickness: Manufacturer's standard for size of sign, but not less than 0.125 inch.
 - b. Surface-Applied Graphics: Applied vinyl film.
 - c. Subsurface Graphics: Reverse halftone, dot-screen image, or etch image.
 3. Sign-Panel Perimeter: Finish edges smooth.
 - a. Edge Condition: Square cut.
 - b. Corner Condition in Elevation: Square.
 4. Mounting: Manufacturer's standard method for substrates indicated. Surface mounted to wall with concealed anchors, countersunk flathead through fasteners, adhesive, two-face tape, hook-and-loop tape, or magnetic tape.
 5. Text and Typeface: Accessible raised characters and Braille as scheduled. Finish raised characters to contrast with background color, and finish Braille to match background color, as selected by Architect from manufacturer's full range.
 6. Color and Finish: As selected by Architect from manufacturer's full range.

2.03 SIGN MATERIALS

- A. Acrylic Sheet: ASTM D 4802, category as standard with manufacturer for each sign, Type UVF (UV filtering).
- B. Vinyl Film: UV-resistant vinyl film with pressure-sensitive, permanent adhesive; die cut to form characters or images as indicated on Drawings.
- C. Paints and Coatings for Sheet Materials: Inks, dyes, and paints that are recommended by manufacturer for optimum adherence to surface and are UV and water resistant for colors and exposure indicated.

2.04 ACCESSORIES

- A. Fasteners and Anchors: Manufacturer's standard as required for secure anchorage of signs, noncorrosive and compatible with each material joined, and complying with the following:

1. Use concealed fasteners and anchors.
2. Sign Mounting Fasteners:
 - a. Concealed Studs: Concealed (blind), threaded studs welded or brazed to back of sign material or screwed into back of sign assembly unless otherwise indicated.
 - b. Through Fasteners: Exposed metal fasteners matching sign finish, with type of head indicated, and installed in predrilled holes.
- B. Adhesive: As recommended by sign manufacturer.
- C. Two-Face Tape: Manufacturer's standard high-bond, foam-core tape, 0.045 inch thick, with adhesive on both sides.
- D. Hook-and-Loop Tape: Manufacturer's standard two-part tape consisting of hooked part on sign back and looped side on mounting surface.
- E. Magnetic Tape: Manufacturer's standard magnetic tape with adhesive on one side.

2.05 FABRICATION

- A. General: Provide manufacturer's standard sign assemblies according to requirements indicated.
 1. Preassemble signs and assemblies in the shop to greatest extent possible. Disassemble signs and assemblies only as necessary for shipping and handling limitations. Clearly mark units for reassembly and installation; apply markings in locations concealed from view after final assembly.
 2. Mill joints to a tight, hairline fit. Form assemblies and joints exposed to weather to resist water penetration and retention.
 3. Conceal connections if possible; otherwise, locate connections where they are inconspicuous.
 4. Provide rabbets, lugs, and tabs necessary to assemble components and to attach to existing work. Drill and tap for required fasteners. Use concealed fasteners where possible; use exposed fasteners that match sign finish.
- B. Subsurface-Applied Graphics: Apply graphics to back face of clear face-sheet material to produce precisely formed image. Image shall be free of rough edges.
- C. Subsurface-Etched Graphics: Reverse etch back face of clear face-sheet material. Fill resulting copy with manufacturer's standard enamel. Apply opaque manufacturer's standard background color coating over enamel-filled copy.

2.06 GENERAL FINISH REQUIREMENTS

- A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

- B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. General: Install signs using mounting methods indicated and according to manufacturer's written instructions.
 - 1. Install signs level, plumb, true to line, and at locations and heights indicated, with sign surfaces free of distortion and other defects in appearance.
 - 2. Install signs so they do not protrude or obstruct ADA compliance.
 - 3. Before installation, verify that sign surfaces are clean and free of materials or debris that would impair installation.
- B. Accessibility: Install signs in locations on walls and according to the accessibility standard.
- C. Mounting Methods:
 - 1. Concealed Studs: Using a template, drill holes in substrate aligning with studs on back of sign. Remove loose debris from hole and substrate surface.
 - a. Masonry Substrates: Fill holes with adhesive. Leave recess space in hole for displaced adhesive. Place sign in position and push until flush to surface, embedding studs in holes. Temporarily support sign in position until adhesive fully sets.
 - b. Thin or Hollow Surfaces: Place sign in position and flush to surface, install washers and nuts on studs projecting through opposite side of surface, and tighten.
 - 2. Through Fasteners: Drill holes in substrate using predrilled holes in sign as template. Countersink holes in sign if required. Place sign in position and flush to surface. Install through fasteners and tighten.
 - 3. Adhesive: Clean bond-breaking materials from substrate surface and remove loose debris. Apply linear beads or spots of adhesive symmetrically to back of sign and of suitable quantity to support weight of sign after cure without slippage. Keep adhesive away from edges to prevent adhesive extrusion as sign is applied and to prevent visibility of cured adhesive at sign edges. Place sign in position, and push to engage adhesive. Temporarily support sign in position until adhesive fully sets.
 - 4. Two-Face Tape: Clean bond-breaking materials from substrate surface and remove loose debris. Apply tape strips symmetrically to back of sign and of suitable quantity to support weight of sign without slippage. Keep strips away from edges to prevent visibility at sign edges. Place sign in position, and push to engage tape adhesive.

5. Hook-and-Loop Tape: Clean bond-breaking materials from substrate surface and remove loose debris. Apply sign component of two-part tape strips symmetrically to back of sign and of suitable quantity to support weight of sign without slippage; push to engage tape adhesive. Keep tape strips 0.250 inch away from edges to prevent visibility at sign edges when sign is initially installed or reinstalled. Apply substrate component of tape to substrate in locations aligning with tape on back of sign; fully engage tape adhesive to substrate.
6. Magnetic Tape: Clean bond-breaking materials from substrate surface and remove loose debris. Apply tape strips symmetrically to back of sign and of suitable quantity to support weight of sign without slippage. Keep strips away from edges to prevent visibility at sign edges. Place sign in position.

3.02 ADJUSTING AND CLEANING

- A. Remove and replace damaged or deformed signs and signs that do not comply with specified requirements. Replace signs with damaged or deteriorated finishes or components that cannot be successfully repaired by finish touchup or similar minor repair procedures.
- B. Remove temporary protective coverings and strippable films as signs are installed.
- C. On completion of installation, clean exposed surfaces of signs according to manufacturer's written instructions, and touch up minor nicks and abrasions in finish. Maintain signs in a clean condition during construction and protect from damage until acceptance by Owner.

END OF SECTION 10 14 23

SECTION 10 21 13
TOILET COMPARTMENTS GENERAL

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 specification sections, apply to this section.
- B. SUMMARY OF WORK: Section 01 11 00:
 - 1. Refer to "PART 2 – PRODUCTS" for all Buy America Build America Act (BABA) Requirements

1.02 SUMMARY

- A. Section Includes:
- B. Stainless Steel toilet compartments configured as toilet enclosures and urinal screens.

1.03 SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
- B. Shop Drawings: For toilet compartments. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Show locations of cutouts for compartment-mounted toilet accessories.
 - 2. Show overhead support or bracing locations.
- C. Maintenance Data: For toilet compartments to include in maintenance manuals.

1.04 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA) and Architectural Barriers Act (ABA) Accessibility Guidelines for Buildings and Facilities" and ICC/ANSI A117.1 for toilet compartments designated as accessible.

1.05 PROJECT CONDITIONS

- A. Field Measurements: Verify actual locations of toilet fixtures, walls, columns, ceilings, and other construction contiguous with toilet compartments by field measurements before fabrication.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Aluminum Castings: ASTM B 26/B 26M.
- B. Aluminum Extrusions: ASTM B 221 (ASTM B 221M).
- C. Stainless Steel Castings: ASTM A 743/A 743M.
- D. Zamac: ASTM B 86, commercial zinc-alloy die castings.

2.02 STAINLESS STEEL UNITS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Accurate Partitions Corporation.
 - 2. Bradley, Corp.
 - 3. Ampco, Inc.
 - 4. Capitol Partitions, Inc.
 - 5. Comtec Industries/Capitol Partitions.
 - 6. General Partitions Mfg. Corp.
 - 7. Global Steel Products Corp.
 - 8. Metpar Corp.
 - 9. Santana Products, Inc.
 - 10. Sanymetal; a Crane Plumbing company.
- B. Toilet-enclosure style: overhead braced, floor anchored, standard industry sized panels and height installation.
- C. Urinal-screen style: wall hung, standard industry sized panels and height installation.
- D. Door, panel, and pilaster: A 666, 300 series commercial stainless steel sheet suitable for exposed applications. Provide smooth material, without creases or ripples.
 - 1. Color and Pattern: As selected by Architect from manufacturer's full range.

2.03 BRACKETS (FITTINGS):

- A. Full-Height (Continuous) Type: Manufacturer's standard design; stainless steel.
- B. Stainless Steel Castings: ASTM A 743/A 743M.

2.04 ACCESSORIES

- A. Hardware and Accessories: Manufacturer's standard design, heavy-duty operating hardware and accessories.
 - 1. Material: Stainless steel.
 - 2. Hinges: Manufacturer's standard paired, self-closing type that can be adjusted to hold doors open at any angle up to 90 degrees.
 - 3. Latch and Keeper: Manufacturer's standard surface-mounted latch unit designed for emergency access and with combination rubber-faced door strike and keeper. Provide units that comply with regulatory requirements for accessibility at compartments designated as accessible.
 - 4. Provide manufacturer's standard "OCCUPIED" indicators at each stall.
 - 5. Coat Hook: Manufacturer's standard combination hook and rubber-tipped bumper, sized to prevent in-swinging door from hitting compartment-mounted accessories.
 - 6. Door Bumper: Manufacturer's standard rubber-tipped bumper at out-swinging doors.
 - 7. Door Pull: Manufacturer's standard unit at out-swinging doors that complies with regulatory requirements for accessibility. Provide units on both sides of doors at compartments designated as accessible.
- B. Overhead Bracing: Manufacturer's standard continuous, extruded-aluminum head rail with antigrip profile and in manufacturer's standard finish.
- C. Anchorages and Fasteners: Manufacturer's standard exposed fasteners of stainless steel or chrome-plated steel or brass, finished to match the items they are securing, with theft-resistant-type heads. Provide sex-type bolts for through-bolt applications. For concealed anchors, use stainless steel, hot-dip galvanized steel, or other rust-resistant, protective-coated steel.

2.05 FABRICATION

- A. Overhead-Braced Units: Provide 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.
- B. Door size and swings: unless otherwise indicated, provide 24-inch-(610-mm-) wide, in-swinging doors for standard toilet compartments and 36-inch-(914-mm-) wide, out-swinging doors with a minimum 32-inch- (813-mm-) wide, clear opening for compartments designated as accessible.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. General: Comply with manufacturer's written installation instructions. Install units rigid,

straight, level, and plumb. Secure units in position with manufacturer's recommended anchoring devices.

1. Maximum Clearances:
 - a. Pilasters and Panels: 1/2 inch.
 - b. Panels and Walls: 1 inch.
 - c. Floor to Panel: 12 inches.
 2. Stirrup Brackets: Secure panels to walls and to pilasters with no fewer than two brackets attached near top and bottom of panel, or an additional number if recommended by manufacturer. Provide adequate blocking in walls as required.
 - a. Locate wall brackets so holes for wall anchors occur in masonry or tile joints.
 - b. Align brackets at pilasters with brackets at walls.
- B. Overhead-Braced Units: Secure pilasters to floor and level, plumb, and tighten. Set pilasters with anchors penetrating not less than 1-3/4 inches (44 mm) into structural floor unless otherwise indicated in manufacturer's written instructions. Secure continuous head rail to each pilaster with no fewer than two fasteners. Hang doors to align tops of doors with tops of panels, and adjust so tops of doors are parallel with overhead brace when doors are in closed position.
1. Minimum Pilaster Width: 10"
- C. Urinal Screens: Attach with anchoring devices to suit supporting structure. Set units level and plumb, rigid, and secured to resist lateral impact. Provide adequate blocking in walls as required.
- D. Install partitions in locations as indicated on the Plans.

3.02 ADJUSTING

- A. Hardware Adjustment: Adjust and lubricate hardware according to hardware manufacturer's written instructions for proper operation. Set hinges on in-swinging doors to hold doors open approximately 30 degrees from closed position when unlatched. Set hinges on out-swinging doors to return doors to fully closed position.

END OF SECTION 10 21 13

SECTION 10 28 13
COMMERCIAL TOILET ACCESSORIES

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes:
 - 1. Commercial toilet accessories as indicated on the Plans and herein specified.
 - 2. Refer to Plans for listing of accessories.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00:
 - 1. Refer to "PART 2 – PRODUCTS" for all Buy America Build America Act (BABA) Requirements
- B. GLASS AND GLAZING: Section 08 81 00.
- C. TILE WORK: Section 09 30 13.
- D. TOILET COMPARTMENTS: Section 10 21 13.

1.03 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Products used in the work of this Section shall be produced by manufacturers regularly engaged in manufacture of similar items and with a history of successful production acceptable to the Engineer.
- B. Codes and Regulations: Comply with requirements of the Florida Building Code.

1.04 SUBMITTALS

- A. Product Data: Submit manufacturer's technical information, catalog cuts, and installation instructions for each product to be furnished and installed.
- B. Warranty: Submit manufacturer's standard 10 year warranty for mirror glass against silver spoilage.

1.05 PRODUCT DELIVERY AND STORAGE

- A. Materials shall be delivered to Site undamaged. Materials shall be stored on the site in an area and in a manner to provide protection from damage until incorporated in the Work.

1.06 JOB CONDITIONS

- A. Inserts and Anchorages: Furnish inserts and anchoring devices which must be set in metal framed or masonry walls; coordinate delivery with other work to avoid delay.

- B. Accessory Locations:
 - 1. Coordinate accessory locations with other work to avoid interference and to assure proper operation and servicing of accessory units.
 - 2. Locations shall comply with State and Federal handicapped accessibility requirements for handicapped accessible units.

PART 2 - PRODUCTS

2.01 MANUFACTURER

- A. Products: Model numbers shown for accessories are units manufactured by Bobrick Washroom Equipment Company, Inc., unless otherwise specified. Provide products by Bobrick or by one of the following manufacturers:
 - 1. A&J Washroom Accessories.
 - 2. American Specialties Inc.
 - 3. Bradley Corp.

2.02 MATERIALS, GENERAL

- A. Stainless Steel: ASTM A 666 Type 304, with polished No. 4 finish, 22 gauge minimum, unless otherwise indicated.
- B. Mirror Glass: ASTM C 0148, Type I, Class 1, Quality q2, 1/4 inch thick, with silvering, copper coating, and protective organic coating complying with FS DD-M-411. Polished edge, fully protected with padding.
- C. Galvanized Steel Mounting Devices: ASTM A 153, hot-dip galvanized after fabrication.
- D. Fasteners: Screws, bolts, and other devices of same material as accessory unit or of galvanized steel where concealed, theft and vandal resistant.

2.03 FABRICATION

- A. General: Stamped names or labels on exposed faces of toilet accessory units are NOT permitted. Where locks are required for a particular type of toilet accessory, provide same keying throughout Project. Furnish two (2) keys for each lock.
- B. Recessed Toilet Accessories: Except where otherwise indicated, fabricate units of all welded construction, without mitered corners. Hang doors or access panels with continuous stainless steel piano hinges. Provide anchorage which is fully concealed when unit is closed.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install toilet accessories in accordance with manufacturer's instructions, using fasteners which are appropriate to substrate and recommended by manufacturer of unit. Install units plumb and level, firmly anchored in locations and at heights indicated.

3.02 ADJUSTING AND CLEANING

- A. Adjust toilet accessories for proper operation and verify that mechanisms function smoothly. Replace damaged or defective items.
- B. Clean and polish all exposed surfaces after removing temporary labels and protective coatings.

3.03 TOILET ACCESSORY SCHEDULE

- A. Refer to Plans for the toilet accessory schedule.

END OF SECTION 10 28 13

SECTION 10 44 16
FIRE PROTECTION ACCESSORIES

PART 1 - GENERAL

1.01 SUMMARY

A. Work of this section shall include the following

1. Fire Extinguishers.
2. Cabinets.
3. Brackets.
4. Accessories.

1.02 RELATED WORK

A. SUMMARY OF WORK: Section 01 11 00:

1. Refer to "PART 2 – PRODUCTS" for all Buy America Build America Act (BABA) Requirements

1.03 QUALITY ASSURANCE

A. Reference Standards:

1. National Fire Protection Association (NFPA):
2. NFPA 10 - Portable Fire Extinguishers.

B. Single Source Responsibility:

C. Provide fire extinguishers, cabinets, brackets, and accessories by single manufacturer.

1.04 REQUIREMENTS OF REGULATORY AGENCIES:

A. All fire extinguishers shall be Underwriters' Laboratories (UL) approved and labeled.

1.05 SUBMITTALS

1.06 PRODUCT DATA:

A. Submit manufacturer's technical data and installation instructions for fire extinguishers and accessories to the Engineer and/or Department for review and approval.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Products: Provide fire extinguishers, cabinets, and accessories by one of the following

manufacturers:

1. J.L. Industries, Inc.
2. Larsen's Manufacturing Company.
3. Potter-Roemer.

2.02 FIRE EXTINGUISHERS

- A. Description: Fire extinguishers shall be multi-purpose, dry chemical type.
- B. Products: Provide one of the following:
 1. "MP 10," Larsen's Manufacturing Company.
 2. "Cosmic 10E," J.L. Industries, Inc.
 3. "3010," Potter-Roemer.

2.03 FIRE EXTINGUISHER CABINETS

- A. Fire extinguisher cabinets shall be used for finished areas, types as follows:
 1. Products, Semi-Recessed (Interior): Provide one of the following cabinets:
 - a. "Architectural Series 2409-5R Full Glass, Acrylic," baked enamel finish; Larsen's Manufacturing Co.
 - b. "Ambassador Series 1017 F 12," baked enamel finish; J.L. Industries, Inc.
 - c. "1700 Series"; Potter-Roemer.
 2. Color shall be white.
- B. Brackets shall be used for all utility/service areas.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install the items of this section in strict accordance with the original design, approved shop drawings, NFPA 10, and requirements of agencies having jurisdiction, as approved by the Engineer and/or Department, anchoring all components firmly into position.

END OF SECTION 10 44 16

SECTION 10 56 26
MOBILE STORAGE SHELVING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Mechanically assisted systems.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Sustainable Design Submittals:
 - 1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
 - 2. Composite Wood Products: Products shall be made without urea formaldehyde.
 - 3. Composite Wood Products: Products shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- C. Shop Drawings: Show shelving layout, location and extent of rail system and clear-aisle widths from face of carriages.
- D. Samples: For each exposed product and for each color and texture specified.
- E. Delegated-Design Submittal: For mobile storage shelving, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.03 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer and manufacturer.
- B. Sample warranty.

1.04 CLOSEOUT SUBMITTALS

- A. Maintenance data.

1.05 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Shelf units and accessories.

1.06 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of mobile shelving systems that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Ten years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Delegated-Design Submittal: For mobile storage shelving, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- B. Structural Performance: Provide mobile shelving systems capable of supporting the following:
 - 1. Load per Linear Foot of Carriage: 1000 lb/ft.
- C. Operating Force: For manually operated systems, maximum 1 lbf 1000 lb

2.02 SYSTEMS AND COMPONENTS

- A. General: Provide manufacturer's standard mobile storage shelving systems and components. Where components are not otherwise indicated, provide manufacturer's standard components as required for a complete system.
- B. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
- C. Inserts: Furnish required concrete inserts and similar anchorage devices for installing track system, and furnish other components of work where installation of devices is specified in another Section.
- D. Flooring: Underlayment thickness required to bring aisle floor finish flush with rail tops.
 - 1. Composite Wood Products: Products shall be made without urea formaldehyde.
 - 2. Composite Wood Products: Products shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
 - 3. Plywood Underlayment: DOC PS 1, Interior, Underlayment.
 - a. Plywood by Pressure Process: Products with a flame-spread index of 25 or less when tested according to ASTM E 84.
- E. Tracks: Steel rails with tops machined to mate with guide wheels and with ends designed to provide smooth, secure continuity between sections without field welding. Provide mounting brackets, anchorage devices, adjustable leveling devices, and stops at terminations of rails to prevent carriages from running off track ends.

1. Mounting: Surface mounted
- F. Carriages: Rigid frames consisting of C-shaped cold-formed steel beams and cross beams, designed to allow secure anchorage of shelving units.
 1. Wheels: Manufacturer's standard number of bearing-mounted, steel wheels, precision ground to mate with tracks.
 2. Bumpers: Provide two rubber bumpers with minimum depth of 1/2 inch each side.
- G. Anti-Tip Brackets: Mount on carriage for engagement with track system to secure units against tipping.
- H. Carriage End Panels: Full depth and height of shelving units. Provide at the operating end of each range.
 1. Material: 0.048 inch

2.03 MECHANICALLY ASSISTED SYSTEMS

- A. Drive Systems: Geared transmission and chain systems with tensioning device to provide mechanical assistance and uniform movement along entire length of each carriage. Permanently shielded and lubricated.
- B. Drive Shaft: Continuous tubular or solid steel shaft, capable of transmitting torque from drive system without distortion.
- C. Locking Pins: Located on range end panels to allow locking of individual range carriage when depressed.

2.04 MATERIALS

- A. High-Pressure Decorative Laminate: NEMA LD 3, Grade VGS.
 1. Colors, Textures, and Patterns: As selected by Architect from manufacturer's full range
- B. Acrylic Sheet: Thermoformable, monolithic sheet, Finish 1 (smooth or polished).
 1. Color: As selected by Architect from manufacturer's full range

2.05 STEEL FINISHES

- A. Baked-Enamel or Powder-Coat Finish: Manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat to achieve a minimum dry film thickness of 2 mils.
 1. Color and Gloss: As selected by Architect from manufacturer's full range

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Level and plumb tracks to a tolerance of 0.09 inch in 120 inches with no more than 0.06-inch variation between adjacent rails. Use permanent shims or non-shrink grout as indicated by manufacturer.
- B. Surface-Mounted Track Systems: Install underlayment, ramps, and finish flooring according to manufacturer's written instructions and flush with track surfaces. Do not extend ramps beyond ends of carriages.
- C. Attach shelving units to carriages according to manufacturer's written instructions and as required to prevent vibration during movement.
 - 1. Level and plumb shelving units to a tolerance of 1/8 inch in 96 inches.

END OF SECTION 10 56 26

SECTION 10 75 16
GROUND-SET FLAGPOLES AND FLAGS

PART 1 - GENERAL

1.01 SUMMARY

- A. The Work specified under this Section includes, but is not limited to, ground-set flagpole(s), as follows:
 - 1. Cone tapered, seamless aluminum flagpoles, exposed height indicated on Plans.
 - 2. Concrete foundation.
 - 3. Standard fittings, including a removable cover for a handhole (approximately 4" wide by 6" high) centered about 1'-0" above base of pole.
 - 4. Lightning ground spike.
 - 5. Two (2) commercial quality, exterior grade 4' x 6' flags; United States and State of Florida.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00:
 - 1. Refer to "PART 2 – PRODUCTS" for all Buy America Build America Act (BABA) Requirements
- B. CAST-IN-PLACE CONCRETE: Section 03 30 00.
- C. EXTERIOR LIGHTING: Division 26.

1.03 QUALITY ASSURANCE

- A. Manufacturer's Qualifications:
 - 1. Provide flagpoles as complete units produced by a single manufacturer, including fittings, accessories, base and anchorage devices.
- B. Erector's Qualifications:
 - 1. Installation shall be performed only by a qualified installer with at least five (5) years documented experience in installations of a similar nature.
- C. Design Criteria:
 - 1. Provide flagpole and installation, including concrete foundation, constructed to withstand wind loads. Use the more stringent design criteria of AASHTO LTS-4 Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals, Latest Adopted Edition, as amended or Florida Building Code, Latest Adopted Edition, as amended.

2. Design for two 4' x 6' flags, in-place, under maximum wind loading. Refer to Plans for additional design criteria.
3. Use heavy pipe sizes if required for the flagpole type and height shown.

1.04 SUBMITTALS

A. Product Data:

1. Submit manufacturer's product data and installation instructions for flagpole required.

B. Shop Drawings:

1. Submit shop drawings of flagpole, flagpole base, and concrete foundation indicating general layout, complete anchoring, supporting systems, and lightning ground spike.
2. Include flagpole, flagpole anchoring system, concrete foundation, and lights mounted to flagpole.
3. All wind load calculations and shop drawings shall be prepared, signed, and sealed by a Professional Engineer registered in the State of Florida.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Spiral wrap flagpole with heavy kraft paper or other protective wrapping and prepare for shipment in hard fiber tube or other protective container.
- B. Deliver flagpole and accessories completely identified for installation. Handle and store flagpole to prevent damage or soiling.
- C. Handle flagpoles only by canvas or nylon slings. No metal chains, fork lifts or any other method which results in metal-to-metal contact is acceptable.

PART 2 - PRODUCTS

2.01 MANUFACTURER

- A. Products: Provide flagpole by one of the following manufacturers:
 1. Adams Flagpole.
 2. AFB/Division of Pole-Tech Co., Inc.
 3. American Flagpole, Division of Kearney-National, Inc.
 4. Concord Industries, Inc.
 5. Ewing Flagpoles.

2.02 MATERIALS

- A. Aluminum Flagpole: Fabricate aluminum flagpole from one-piece, seamless extruded tubing complying with ASTM B 241, alloy 6063-T6, having a minimum wall thickness of 0.188-inch, tensile strength not less than 35,000 psi, and a yield point of 30,000 psi. Heat-treat and age-harden aluminum flagpole.
- B. Flagpole Taper: Cone taper shall be manufacturer's standard one-piece, seamless, uniform, straight line tapered section having a cylindrical butt section.
- C. Flagpole Base:
 - 1. Base Plate: For anchor-bolt mounting, furnish manufacturer's standard cast metal shoe base of the same material as the flagpole, unless otherwise indicated. Furnish and install anchor bolts and lightning ground spike as required.
 - 2. Foundation Tube: Provide 16-gauge minimum, galvanized corrugated steel tube, or 12-gauge rolled steel tube, sized to suit the flagpole and installation. Furnish complete with welded steel bottom base and support plate, lightning ground spike, and steel centering wedges, all welded construction. Provide loose hardwood wedges at top for plumbing pole after erection. Galvanize steel parts after assembly including foundation sleeve.
- D. Flagpole Height: Flagpole exposed height shall be as indicated on Plans.
- E. Flagpole Finish: Flagpole shall receive a fine directional, medium satin polish (AA-M32); buff complying with AA-M20; and seal aluminum surfaces with clear, hard-coat wax.
 - 1. Color: To be selected by Engineer or Owner.
- F. Flagpole Fittings:
 - 1. Finial ball shall be flush seam 14-gauge spun aluminum on 3/4-inch aluminum tube, size to match pole diameter. Finish to match flagpole.
 - 2. Aluminum truck shall be stainless steel ball-bearing, with 1-1/8 inch diameter Celcon sheaves.
 - 3. Cleats shall be two (2) 9-inch cast aluminum cleats and aluminum fastenings. Finish to match flagpole.
 - 4. Halyards: Provide two (2) continuous halyards for each flagpole, as follows:
 - a. Type: Polypropylene, white, braided.
 - b. Size: 5/16-inch (No. 10).
 - 5. Halyard Flag Snaps: Provide two (2) white vinyl covered aluminum swivel snaps per halyard.
 - 6. Light Fixture(s): See Plans for number and type required.

7. Handhole: Provide for access to electrical connections. See Electrical Drawings.

G. Miscellaneous Materials:

1. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107.
2. Drainage Material: Crushed stone, or crushed or uncrushed gravel; coarse aggregate.
3. Sand: ASTM C33, fine aggregate.
4. Elastomeric Joint Sealant: Multicomponent nonsag urethane joint sealant complying with requirements in Section 07 92 00 – JOINT SEALANTS.
5. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187.

PART 3 - EXECUTION

3.01 INSPECTION

- A. Examine surfaces and structure on which the flagpole is to be erected and grounded. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Foundation:

1. Excavate for foundation concrete to neat clean lines. Provide forms where required due to unstable soil conditions. Remove wood, loose soil, rubbish and other foreign matter from the excavated area, and wet the earth before placing concrete. Install foundation tube and level per manufacturer's instructions.
2. Provide OWNER Class I, 3,000 psi concrete at 28-days for base around foundation tube placed immediately after mixing. Compact concrete in place by the use of vibrators. Moist-cure exposed concrete for not less than 7-days, or use an approved non-staining curing compound. Finish trowel exposed concrete surfaces to smooth, dense surface. Provide positive slope for water runoff to base perimeter.

B. Flagpole:

1. Install flagpole as shown and in compliance with approved shop drawings and the manufacturer's published instructions.
2. Foundation Tube: Place flagpole in tube, seated on bottom plate between steel centering wedges, and install hardwood wedges to secure flagpole in place. Place and compact sand in foundation tube and remove hardwood wedges. Seal top of foundation tube with a 2-inch layer of elastomeric joint sealant and cover with flashing collar.
3. Provide positive lightning ground for flagpole installation.
4. Paint all portions of flagpole below grade with a heavy coat of bituminous paint.

5. No metal chains, fork lifts or any other method which results in a metal to metal contact is acceptable. Any damage to the finish shall be repainted to match in the field and approved by the Engineer or Owner prior to Final Acceptance.

END OF SECTION 10 75 16

SECTION 11 30 13
RESIDENTIAL KITCHEN APPLIANCES

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes residential kitchen appliance as follows:

1. ADA compliant Refrigerator/Freezer combo

1.02 RELATED WORK

A. SUMMARY OF WORK: Section 01 11 00:

1. Refer to "PART 2 – PRODUCTS" for all Buy America Build America Act (BABA) Requirements.

1.03 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Appliances provided shall be produced by manufacturers regularly engaged in manufacture of similar items and with a history of successful production acceptable to the Engineer.

1.04 SUBMITTALS

A. Product Data: Submit manufacturer's product data including technical information, catalog cuts, and installation instructions for each product to be furnished and installed.

1.05 PRODUCT DELIVERY AND STORAGE

A. Appliances shall be delivered to Site undamaged. Materials shall be stored inside in an area and in a manner to provide protection from damage until incorporated in the Work.

1.06 WARRANTY

A. Manufacturer agrees to repair or replace residential appliances or components that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Two years for date of Final Acceptance.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Electrical Appliances: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.02 REFRIGERATOR/FREEZER

A. Three-door refrigerator/freezer with freezer on top and complying with AHAM HRF-

1. Type: Freestanding.

2. Storage Capacity:
 - a. Refrigerator Compartment: 20 cu. ft. min.
 - b. Freezer Volume: 5.13 cu. ft.
3. General Features:
 - a. Automatic icemaker.
 - b. Interior light in refrigerator compartment.
 - c. Automatic defrost.
4. ENERGY STAR: Provide appliances that qualify for the EPA/DOE ENERGY STAR product labeling program.
5. Front Panels: Stainless steel.

2.03 MICROWAVE

- A. Type: Free standing
- B. Size: 1.5 cu. ft. min
 1. ENERGY STAR: Provide appliances that qualify for the EPA/DOE ENERGY STAR product labeling program.

2.04 DISHWASHER

- A. Size: 18 (W) x 32 (H) x 22.5 (D)
- B. Automatic Temperature Control, Cycle Status Lights, Hard Food Disposer, Hard Food Filter
- C. ENERGY STAR: Provide appliances that qualify for the EPA/DOE ENERGY STAR product labeling program.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Freestanding Equipment: Place units in final locations after finishes have been completed in area. Verify that clearances are adequate to properly operate equipment.

3.02 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 1. Perform visual, mechanical, and electrical inspection and testing for each appliance according to manufacturer's written recommendations. Verify compliance with each manufacturer's appliance-performance parameters.
 2. Operational Test: After installation, start units to confirm proper operation.

3. Test and adjust, as applicable, controls and safeties. Replace damaged and malfunctioning controls and components.
- B. An appliance will be considered defective if it does not pass tests and inspections.

END OF SECTION 11 30 13

SECTION 12 36 61
QUARTZ AGGLOMERATE COUNTERTOPS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes quartz agglomerate countertops, backsplashes, end splashes and sill plates for counters in maintenance staff, security office counter and sill plates at restrooms.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00:
 - 1. Refer to "PART 2 – PRODUCTS" for all Buy America Build America Act (BABA) Requirements
- B. INTERIOR ARCHITECTURAL WOODWORK: 06 41 23.
- C. COMMERCIAL TOILET ACCESSORIES: Section 10 28 13.
- D. RESIDENTIAL KITCHEN APPLIANCES: Section 11 30 13.

1.03 SUBMITTALS

- A. Product Data: For countertop material.
 - 1. Include construction details, material descriptions, dimensions of individual components, profiles and finishes.
- B. Shop Drawings: For countertops, show materials finishes, edge and backsplash profiles, methods of joining, and cutouts for plumbing fixtures.
 - 1. Show locations and details of joints.
 - 2. Show direction of directional pattern, if occurring.
- C. Samples for Verification: For the following products:
 - 1. Countertop material, 6-inches square.
 - 2. Backsplash and end splash, full size x 10-inches long.
- D. Qualification Data; for fabricator.
- E. Maintenance Data: For quartz agglomerate countertops to include in maintenance manuals. Include product data for care products used or recommended by installer and names, addresses and telephone numbers of local sources for products.

1.04 QUALITY ASSURANCE

- A. Fabricator Qualifications: Shop that employs skilled workers who custom-fabricate

countertops similar to that required for this Project, and whose products have a record of successful in-service performance.

- B. Installer Qualifications: Fabricator of countertops.

1.05 PROJECT CONDITIONS

- A. Field Measurements: Verify dimensions of countertops by field measurements prior to fabrication.
- B. Coordination: Coordinate locations of utilities that will penetrate countertops or backsplashes.

PART 2 - PRODUCTS

2.01 QUARTZ AGGLOMERATE COUNTERTOP MATERIAL

- A. Quartz Agglomerate: Solid sheets consisting of quartz aggregates bound together with a matrix of filled plastic resin and complying with ICPA SS-1, except for composition.
 - 1. Colors and Patterns: As selected by Engineer from manufacturer's full range.

2.02 FABRICATION

- A. Fabricate countertops according to quartz agglomerate manufacturer's written instructions and the AWI/AWMAC/WI's "Architectural Woodwork Standards.
- B. Configuration:
 - 1. Edges: Straight, typical.
 - 2. Backsplash: Straight edges, mitered at corners, typical.
 - 3. End Splash and end panel (if occurring): Matching backsplash.
- C. Countertops: 1-inch thick quartz agglomerate with front edge of same material.
- D. Backsplashes, end splashes, and end panels (if occurring): Same as countertop. Heights vary by condition. Refer to Plans.
- E. Fabricate tops with shop-applied edges and backsplashes unless otherwise indicated. Comply with quartz agglomerate manufacturer's written instructions for adhesives, sealers, fabrication and finishing.
- F. Joints: Fabricate countertops without joints unless approved by the Engineer. Where joints are required, show locations on shop drawings with approval of the Engineer and as follows:
 - 1. Joint Locations: Not within 18-inches of a sink and not where a countertop section less than 36-inches long would result unless unavoidable.
 - 2. Joint Type: Bonded, 1/32-inch or less in width.

3. Splined Joints: Accurately cut kerfs in edges at joints for insertion of metal splines to maintain alignment of surfaces at joints. Make width of cuts slightly more than thickness of splines to provide snug fit. Use at least three splines in each joint.
- G. Cutout and Holes:
1. Undercounter Plumbing Fixtures (if occurring): Make cutouts for fixtures in shop using template or pattern furnished by fixture manufacturer. Form cutouts to smooth even curves.
 - a. Provide vertical edges, rounded to 3/8-inch radius at juncture of cutout edges with top surface of countertop, slightly eased at bottom, and projecting 3/16-inch into fixture opening.
 2. Counter-Mounted Plumbing Fixtures (if occurring): Prepare countertops in shop for field cutting openings for counter mounted fixtures. Mark tops for cutouts and drill holes at corners of cutout locations. Make corner holes of largest radius practical.
 3. Fittings: Drill countertops in shop for plumbing fittings, undercounter soap dispensers, and similar items, as applicable.

2.03 INSTALLATION MATERIALS

- A. Adhesive: Product recommended by quartz agglomerate manufacturer.
- B. Sealant for Countertops: Comply with requirements of Section 07 92 00 – JOINT SEALANTS,

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates to receive quartz agglomerate countertops and conditions under which countertops will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of countertops.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Install countertops level to a tolerance of 1/8 inch in 8 feet, 1/4 inch maximum. Do not exceed 1/64-inch difference between planes of adjacent units.
- B. Fasten countertops by screwing through corner blocks of base units into underside of countertop. Predrill holes for screws as recommended by manufacturer. Align adjacent surfaces and, using adhesive in color to match countertop, form seams to comply with quartz agglomerate manufacturer's written instructions. Carefully dress joints smooth, remove surface scratches, and clean entire surface.
- C. For countertops installed over a plywood base, comply with the following:

1. Fasten subtops to cabinets by screwing through subtops into cornerblocks of base cabinets. Shim as needed to align subtops in a level plane.
 2. Secure countertops to subtops with adhesive according to quartz agglomerate manufacturer's written instructions. Align adjacent surfaces and, using adhesive in color to match countertop, form seams to comply with quartz agglomerate manufacturer's written instructions. Carefully dress joints smooth, remove surface scratches, and clean entire surface.
- D. If joints are required (as approved by the Engineer); bond joints with adhesive and draw tight as countertops are set. Mask areas of countertops adjacent to joints to prevent adhesive smears.
1. If required or as determined by Engineer, install metal kerfs in countertop edges at joints. Fill kerfs with adhesive prior to inserting splines and remove excess immediately after adjoining units are drawn into position.
 2. Clamp units to temporary bracing, supports, or each other to ensure that countertops are properly aligned and joints are of specified width.
- E. Install backsplashes and end splashes by adhering to wall and countertops with adhesive. Mask areas of countertops and splashes adjacent to joints to prevent adhesive smears.
- F. Install aprons (if occurring) to backing and countertops with adhesive. Mask areas of countertops and splashes adjacent to joints to prevent adhesive smears.
- G. Complete cutouts not finished in shop. Mask areas of countertops adjacent to cutouts to prevent damage while cutting. Make cutouts to accurately fit items to be installed, and at right angles to finished surfaces unless beveling is required for clearance. Ease edges slightly to prevent snipping.
- H. Apply sealant to gaps at walls; comply with Section 07 92 00 – JOINT SEALANTS.

END OF SECTION 12 36 61

SECTION 12 59 00
SYSTEMS FURNITURE

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes provisions for modular control room furniture systems as indicated on the Plans.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00:
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) Requirements

1.03 SUBMITTALS

- A. Product data: Manufacturer’s data sheets on each product to be used, including standard installation instructions and requirements.
- B. Shop Drawings: Submit shop drawings indicating material characteristics, details of construction, connections, and relationship with adjacent construction.
- C. Samples: For each product or component, provide two sample sets for all standard manufacturer finishes, and representing actual product and finish.

1.04 QUALITY ASSURANCE

- A. Manufacturer qualifications: Minimum 5 years’ experience manufacturing similar products and systems.
- B. Installer qualifications: Minimum 3 years’ experience manufacturing similar products and systems.
- C. Mock-up: Provide mock-up on site for one module of the furniture system in place, inclusive of all wiring, system connectivity to building, system components, and selected finishes. Do not proceed with full scope of work until workmanship and configuration is reviewed and approved.

1.05 MAINTENANCE

- A. Operational Service: Provide standard manufacturer’s maintenance service agreement for system furniture installed in project. Service shall reclaim materials for recycling and/or reuse. Service shall not landfill or burn reclaimed materials.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store products in manufacturer’s unopened packaging bearing the brand name and manufacturer’s identification until ready for installation.

- B. All components will be flat packed with protective packaging between components and placed on shippable pallet with outer corrugated packaging and protective wrap and shall be suitable for storage and shipping to site without damage.
- C. Handle and store all materials and components to avoid damage.

1.07 PROJECT CONDITIONS

- A. Maintain environmental conditions within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's recommended limits.

1.08 WARRANTY

- A. Provide lifetime warranty on all fixed steel structure frame components.
- B. Provide 5-year warranty on adjustable, sliding or hinged components and laminated surfaces.
- C. Provide 5-year warranty on motorized 3-stage lifting columns for sit-stand surfaces.

PART 2 - PRODUCTS

2.01 MANUFACTURER

- A. Basis of Design: E-Systems Group, Contour Console System

2.02 GENERAL

- A. Contour Command Center and Monitoring Consoles: See Contour Engineering Package for typical styles and measurements.
- B. The contractor to supply a system capable of supporting specified electronics and operator equipment.
- C. The system shall be comprised of self-supporting base frames and leg assemblies and/or intermediate connecting frames with decorative end panels or flush-mount steel trim kits. The system will also feature a stackable 12" and 16" wall frame with integrated aluminum slat wall mounting system for monitors and standard slat wall accessories.
- D. The system shall have a minimum 1-1/8" thick industrial grade 45 lb. particle board core work surface with a protective vinyl T-mold nosing. The work surface shall be 24" or 30" deep overall and finished with a high-pressure decorative laminate overlay on top and warp resistant backer on the bottom.
- E. Tapped or Square Hole rack rails for upper 19" rack-mount storage shall comply with Electronic Industry Association (E.I.A.) specifications for rack mounting ANSI/E standard RS-310. Monitor mounts shall comply with the Video Electronics Standards Association (VESA) standard mounting hole patterns.
- F. All monitor mounts used with the Slat wall System are compliant with the Mounting Interface Standard established by the Video Electronics Standards Association (VESA).

2.03 MODULAR PRE-ENGINEERED CONSTRUCTION

- A. All components within the system shall be:
 - 1. Of a pre-engineered modular construction, i.e.: constructed from a series of independent sectional units.
 - 2. Available from a pre-defined set of manufacturers model numbers.
 - 3. Free from alterations to the design either prior to or following installation.
 - 4. The assembly of the console shall be accomplished without the need for either welding or carpentry work.
 - 5. Constructed of a steel-structure framework with the ability to gang a continuous run of frames without breaks or creep to fit space or room dimensions.

2.04 SELF-SUPPORTING SKELETON FRAMEWORK

- A. The self-supporting skeleton framework shall:
 - 1. Be installed at the site in advance of any optional external finishing panels. The framework shall be fully capable of supporting all specified electronics without the need for attachment of any external panels.
 - 2. Be capable of being supplied to site in knockdown (flat packed) form and capable of assembly using common hardware without welding or carpentry work.

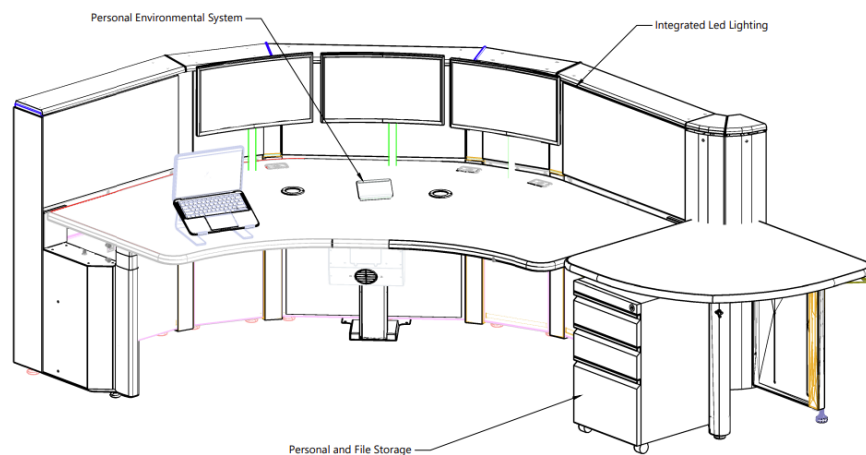
2.05 COMPONENTS

- A. Based Frames and Connecting Frames: 12-gauge fully welded frames shall be a minimum of 6" in width and capable of supporting fully loaded console. Frames shall incorporate threaded adjustable glides and engineered with multiple round and oval cable pass-thru for lateral and vertical cable routing without special connections or conduits between adjoining frames.
- B. Service Panels: Solid and vented quick release service doors for easy removal without the use of tools. Doors shall be supplied with a keyed-alike locking lever latch. Doors shall be able to accept optional CPU roll-out shelf or affixed shelf platform for convenient swing-out access.
- C. Corners: 15, 30, 45, and 90-degree 12-gauge steel corner connectors shall be available. Corners shall connect in the same fashion as base frames for ease of installation. 15, 30, and 45-degree corners shall be available in convex and concave configurations.
- D. Duct or Raceway Cover: Steel hinged duct cover conceals and allows easy access to cable raceway, and can be completely removed without tools for total service access. Raceway cover includes full-width brush strip for desktop wiring entry into framework.
- E. Data/Power Raceway shall include cable grommets and openings for a universal data mounting plate and openings for duplex power outlets. Raceways mount internally within a base frame at user-defined heights and locations and attach to slotted vertical standards

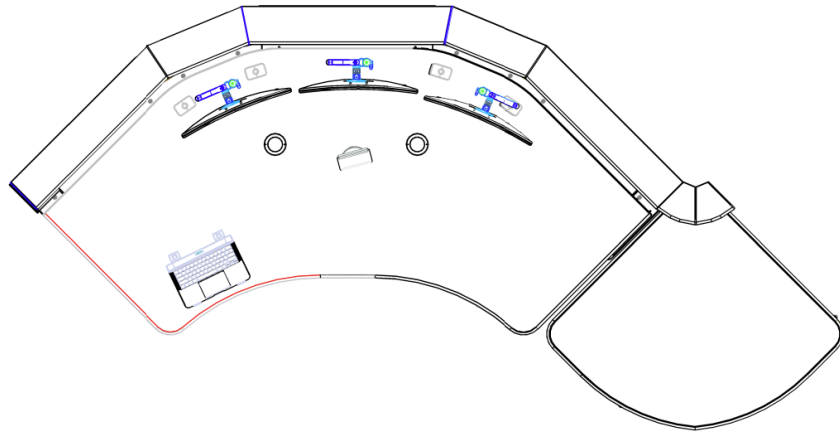
within framework.

- F. Slat Wall Mounting System: Fully integrated anodized aluminum slat walls capable of supporting a wide variety of monitor mounts and standard slat wall accessories. The slat wall shall be constructed of extruded T8 aluminum that securely mounts at multiple display wall vertical standards for maximum load capacity. The slat wall shall flush mount to adjacent slat wall frame sections without gaps for a seamless mounting channel to support monitor mounts, lighting and work-in-process storage accessories.
- G. Lift-Off Back Panel: Vented lift-off back panel matches Front Service panels and shall operate in the same fashion.
- H. Electric Lift Legs: 3-stage electric lifting columns shall be available for sit-stand single surfaces and dual-surface corner configurations. The electric lift legs shall offer three programmable height settings and provide quick and easy work surface adjustment from 25” to 51” high from the floor with travel speed up to 43mm/second and capable of 700N thrust per motorized leg assembly.
- I. Hardware: Provide all mounting and assembly hardware as required.
- J. File Drawers: Lockable drawers for personal use shall be provided at intersections of workstations.
- K. Laptop Stand: Laptop stand with mesh backing for laptop venting and cooling.
- L. Personal Climate System: Each station shall have its own climate control system for user comfort.
- M. Integrated LED Lighting: Each station shall have personal LED lighting with user control system.

2.06 STATION REPRESENTATION (NOT TO SCALE)



A.



B.

2.07 FINISH AND COLOR

- A. All frame steel components including service doors/panels, CPU hardware storage modules, raceway covers, and shelving shall be zinc oxide wash primer with a powder coat textured finish.
- B. Metal Finish: Provide samples
- C. Counter Color: Provide samples

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Locate and place systems furniture unit's level, plumb, and at indicated alignment with adjacent work.
- B. Repair finishes damaged. Restore finishes so no evidence remains of corrective work. Return items that cannot be refinished in the field to the factory, make required alterations, and refinish entire unit or provide new units.

3.02 ADJUSTING, CLEANING, AND PROTECTING

- A. Before final inspection, clean exposed surfaces.
- B. Protect systems furniture units from damage after installation. Use temporary protective coverings where needed.

END OF SECTION 12 59 00

SECTION 21 00 00
FIRE PROTECTION REQUIREMENTS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.
- B. Work herein shall conform to all applicable laws, ordinances, and to regulations of the local utility companies. The general conditions and all requirements of the contract documents shall apply to all work of this section. Work shall be in accordance with the requirements of:
 - 1. Florida Building Code (FBC) 8th Edition (2023): This code includes the 2023 FBC Building, Mechanical, Plumbing, Energy Conservation, Fuel Gas, Accessibility, and Test Protocols volumes. Further, see "Referenced Standards" in the FBC Building Chapter 35; FBC Mechanical Chapter 15; FBC Plumbing Chapter 15; FBC Energy Conservation Chapter 6; and FBC Fuel Gas Chapter 8) (Effective December 31, 2023).
 - 2. 8th Edition of the Florida Fire Prevention Code (FFPC): This code also includes the Florida versions of NFPA 1 and NFPA 101. (Effective December 31, 2023).
 - 3. 2020 National Electric Code.
- C. Cooperate with all other trades and install work as fast as the progress of the job will permit.
- D. Use only mechanics skilled in the work they are to perform and have a competent representative on the job when any work is being done.
- E. No work shall be done unless the Superintendent of the Contractor is on the job site. Work shall be properly protected, all rubbish removed promptly, and exposed work shall be carefully cleaned prior to final acceptance.
- F. The term "provide" shall include labor, materials, and equipment necessary to furnish and install, complete and operable, the item or system indicated.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00.
 - 1. Refer to "PART 2 – PRODUCTS" for all Buy America Build America Act (BABA) requirements.

1.02 SPECIFICATIONS AND DRAWINGS

- A. Plans show location of fixtures and equipment and are intended to depict the general intent of the work in scope, layout and quality of workmanship. They are not intended to show in minute detail every or all accessories intended for the purpose of executing the work, but it is understood that such details are a part of this work.

- B. Keep a record of the locations of concealed work and of any field changes in Contract Drawings and Specifications for each trade and, upon completion of the job. Refer to Specification Section 01 7000, "Closeout" for requirements.

1.03 PERMITS, FEES AND INSPECTIONS:

- A. The Contractor shall give all necessary notices, obtain all permits and pay all government fees in accordance with the Supplementary Conditions, sales taxes and other costs, including utility connections or extensions, in connection with this work; file all permit applications required by all governmental departments having jurisdiction.
- B. Obtain all required certificates of inspection for work and deliver them to the Owner before requesting acceptance and final payment for the work.
- C. The Contractor shall include in the work, without extra cost to the Owner, any labor, materials, services, apparatus and drawings required to comply with all applicable laws, ordinances, rules and regulations.

1.04 GENERAL

- A. Materials or products specified herein and/or indicated on drawings by trade name, manufacturer's name and/or catalog number shall be provided as specified. Substitutions will not be permitted except as described herein and in the Supplementary and General Conditions.
- B. Since manufacturers reserve the right to change their products at any time, contractors shall verify all dimensions, performance data, etc. for each piece of equipment submitted to assure compliance with the intent of the drawings and specifications.
- C. All materials shall be new and of quality as specified, and when available, be clearly labeled and/or stamped as manufactured in the United States.
- D. Where an accepted substitution or deviation requires different quantity or arrangement of foundations, supports, ductwork, piping, wiring, conduit, and any other equipment or accessories normal to this equipment, contractor shall furnish said changes and additions and pay all costs for all changes and additions to his work and the work of others affected by this substitution or deviation.
- E. Deviations mean the use of any listed approved manufacturer other than those on which the drawings are based.

1.05 SHOP AND ERECTION DRAWINGS AND SAMPLES

- A. All submittals shall include adequate descriptive literature, catalog cuts, shop drawings and other data necessary for the Architect/Engineer to ascertain that the proposed equipment and materials comply with specification and drawing requirements. Catalog cuts submitted for approval shall be legible and clearly identify equipment being submitted.
- B. Shop and erection drawing submittals shall conform to the requirements of the General Conditions and Division 00 specifications except as modified herein.
- C. Shop drawings shall consist of manufacturer's scale drawings, cuts or catalogs, including descriptive literature which shall clearly indicate the construction, material, physical

dimensions, wiring diagrams and complete operating data clearly marked for each item. Data of general nature will not be accepted.

- D. Shop drawings shall be in PDF format and submitted electronically.
1. Coordination drawings shall show major elements, components, and systems of mechanical equipment and materials in relationship with other building components. Prepare drawings to an accurate scale of 1/4"=1'-0" or larger. Indicate the locations of all equipment and materials, including clearances for installing, servicing and maintaining equipment, valve stem movement, and similar requirements. Indicate movement and positioning of large equipment into the building during construction.
- E. Submittals for individual systems and equipment assemblies which consist of more than one item or component shall be made for the system or assembly as a whole. Partial submittals will not be considered for approval. Submittals shall be submitted for all applicable products and materials specified in each individual section of these specifications.
- F. Make submittals for the equipment and materials in accordance with the following:
1. Mark the submittals, "SUBMITTED UNDER SECTION_____".
 2. Submittals shall be marked to show specification reference including the section and paragraph numbers.
 3. The submittals shall include the following:
 - a. Information that confirms compliance with contract requirements. Include the manufacturer's name, model or catalog numbers, catalog information, technical data sheets, shop drawings, pictures, nameplate data and test reports as required. Provide any additional information specifically requested in the individual specification section or on the drawings.
 - b. Parts list which shall include those replacement parts recommended by the equipment manufacturer, quantity of parts, current price and availability of each part.
 4. Electronic PDF submittal files shall be named utilizing the specification number followed by a sequential number for the submittal made under the given specification number followed by "r#" if it is a resubmittal, and then followed by a brief description of the submitted item.
 - a. The description shall indicate the actual item submitted, shall not be general in nature, and does not have to be that of the specification section heading.
 - b. Using the example, "21 05 29-4r2 Hangers"; 21 05 29 – Fire Protection Supports and Anchors is the relevant specification, the "4" shows it was the fourth submittal for specification section 21 05 19 02,"r2" shows it was the second resubmittal, and the description indicates what item is submitted.
 - c. Each specification item shall be submitted in a separate PDF file. PDF files with multiple specification items will be returned without review.
 - d. Each file shall have sufficient space allowance for the Architects and Engineer's review stamp(s).
 - e. Each file shall have the Constructions Managers review stamp(s) and indicate information required by specification 21 00 00.1.5K.

- G. Shop drawings on paper 11”X17” or smaller in size shall be submitted in a tabbed and indexed three ring binder. The binder shall not exceed 11-5/8” height. Partial submittals are unacceptable. The index shall indicate the related specification section number.
- H. Carefully examine all shop drawings and mark-up as necessary before submitting to the Architect/Engineer for review. The consultant will only consider shop drawings bearing the contractor’s stamp of approval.
- I. The engineer’s review shall not relieve the contractor from the responsibility for deviations from drawings and specifications. The engineer’s review shall be construed to apply only to general arrangement and shall not relieve the contractor from the responsibility for the correctness of details and dimensions and provision of the correct equipment.
- J. The contractor shall retain copies of all reviewed shop drawings on the job site for reference.
- K. In addition to the requirement of SUBMITTALS, the Owner reserves the right to request the manufacturer to arrange for the Owner’s representative(s) to see typical active systems in operation, when there has been no prior experience with the manufacturer or the type of equipment being submitted.

1.06 EXPERIENCE

- A. The Contractor performing this work shall be a licensed, reputable firm, regularly performing the type of work incorporated in this project and who also maintains, as part of the firm, a service department with qualified personnel who regularly perform this type of work. The Contractor shall, upon request, show evidence of at least two jobs of similar character and size installed within the preceding two years.

1.07 COORDINATION WITH OTHER TRADES

- A. Contractor shall coordinate his work with other trades to avoid interferences and delays. He shall assist in working out space requirements to make a satisfactory installation.
- B. If the Contractor installs his work before coordinating with other trades, or so as to cause any interference with the work of other trades, he shall make the necessary changes in his work to correct the condition without extra charge.
- C. The Contractor shall furnish to other trades, as required, all necessary templates, patterns, setting plans, and shop details for the proper installation of work and for the purpose of coordinating adjacent work.

1.08 STORAGE OF MATERIALS

- A. All materials stored on site shall be properly protected from injury or deterioration. Materials shall not be stored in contact with ground or floor.
- B. Do not remove manufacturer's packing materials until ready to install. Materials showing signs of corrosion, improper handling or storage shall be replaced at no cost to the Owner.
- C. Provide continuous protection for all equipment already installed.

1.09 CUTTING, PATCHING, EXCAVATION, BACKFILL, AND LAYOUT

- A. Provide openings and excavation required for the installation of the work. Patch work and backfill as required. Finished work shall match the existing adjoining work.
- B. Verify all conditions affecting the work to be performed under this contract.
- C. Carefully verify measurements at the site, determine the exact location of chases and openings required. Provide sleeves, inserts, and hangers as required. No columns, beams, joists, building foundations or any other structural building component shall be cut, drilled or disturbed in any way. Conflicts shall immediately be brought to the attention of the Architect/Engineer.
- D. All excavation on sites containing existing buildings and existing services shall be done with hand shovel to avoid damage to existing services. Any damage incurred by the Contractor shall be repaired by the Contractor in a manner approved by the Architect/Engineer at no cost to the Owner and with no extension of time limitation.

1.10 REMOVAL OF RUBBISH

- A. Contractor shall keep premises free from accumulations of waste material or rubbish caused by his employees or work in accordance with Division 00 - Construction Procedures. At completion of work, he shall remove all his tools, scaffolding, surplus materials, and rubbish from building and site. He shall leave premises and his work in a clean orderly condition acceptable to the Architect/Engineer.

1.11 EQUIPMENT IDENTIFICATION

- A. Each unit shall be identified by its service and other appropriate designation by stenciling in letters of approved size and wording. Equipment requiring identification shall include: valves, piping, and other equipment as may be directed by the Architect/Engineer.

1.12 CLEANING AND ADJUSTMENTS

- A. Scratched or damaged painting shall be touched up as necessary to return the painting to "new" condition and appearance.
- B. All piping and equipment shall be thoroughly blown out under pressure and cleared of all foreign matter, wasting air, gas or water through temporary connections as long as necessary to thoroughly clean system before system is placed in operation. Use every precaution to prevent pipe compound, scale, dirt, welding and other objectionable matter from getting into the piping system and equipment.
- C. All cleaning shall be done prior to any sterilization, pressure testing, flow balancing or equipment adjustment procedures.
- D. During construction protect all piping and equipment from damage and dirt. Cap the open ends of all piping and equipment.

1.13 WATERPROOFING

- A. Where any work pierces waterproofing including waterproof concrete, the method of installation shall be as approved by the Owner before the work is done.

- B. Provide all necessary sleeves, caulking and flashing required to make openings absolutely watertight. Waterproof flashing materials shall be compatible with base materials.

1.14 TESTS

- A. Contractor shall make all tests required to establish the adequacy, quality, safety, completed status and satisfactory operation of all systems to the satisfaction of the Architect/Engineer. Provide all instruments, labor and services necessary to conduct tests.

1.15 INSTRUCTIONS

- A. Fully instruct Owner's personnel in the care and operation of systems and furnish a letter to the Architect/Engineer advising the particular person who has received such instruction.

1.16 WARRANTY

- A. Equipment shall be started, tested, adjusted, and placed in satisfactory operating condition. Furnish a letter addressed to the Architect/Engineer advising that the completed systems have been installed in accordance with the Plans and Specifications and that they are in proper operating condition. The Owner shall receive a written warranty covering all defects in workmanship and material for a period of one year from date of final acceptance. Any defects appearing within this one year period shall be repaired without additional cost to the Owner.

1.17 ACCEPTANCE

- A. Before requesting final inspection:
 - 1. Complete all work required. If any items are held in abeyance as incomplete for final inspection, list such items together with explanation for delay.
 - 2. Submit statement that equipment is properly installed, adjusted, fully lubricated and operation is satisfactory.
 - 3. Certify in writing to the Architect/Engineer that the Owner's representative has been instructed as to the care and operation of the system and that catalog service and maintenance information has been turned over to the Architect/Engineer.
 - 4. Submit copy of written guarantee.
 - 5. Submit copy of other data as may be outlined in these specifications.
- B. Copies of the above data shall be submitted to the Architect/Engineer prior to requesting final inspection.

1.18 FACILITY STARTUP BROCHURE

- A. At the completion of work, Contractor shall provide startup instruction in accordance with Division 00, "Closeout" and shall submit a bound brochure containing the following:
 - 1. Shop Drawings
 - 2. Maintenance Manuals

3. Control Wiring and Piping Diagrams
 4. Operating Instructions
 5. Copy of Guarantee
 6. Certificate of Instruction of Owner's Representative
 7. Certificate of Job Completion
 8. Record Documents
- B. Where projects are of sufficient size to make a single brochure impractical, several brochures shall be prepared by trade and As-Built Drawings may be submitted as a separate item.
- C. Brochure shall be indexed and divided for reasonable clarity.
- D. Brochure shall be turned over to the Architect/Engineer for review and approval. The contractor shall make modifications to the brochure as deemed necessary for compliance and clarity, by the Architect/Engineer, and re-submit the final brochure to the Architect/Engineer to be forwarded to the Owner.

END OF SECTION 21 00 00

SECTION 21 05 17
SLEEVES AND SLEEVE SEALS FOR FIRE-SUPPRESSION PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00.
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) requirements.

1.03 SUMMARY

- A. Section Includes:
 - 1. Sleeves.
 - 2. Stack-sleeve fittings.
 - 3. Sleeve-seal systems.
 - 4. Sleeve-seal fittings.
 - 5. Grout.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

PART 2 - PRODUCTS

2.01 SLEEVES

- 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.

2.02 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.

2.03 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.

2.04 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.

2.05 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: 5,000-psi (34.5-MPa), 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.01 SLEEVE INSTALLATION

- A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
- B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.
- C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.

1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
 2. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.
 3. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.
- D. Install sleeves for pipes passing through interior partitions.
1. Cut sleeves to length for mounting flush with both surfaces.
 2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
 3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Section 07 92 00 "Joint Sealants."
- E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

3.02 STACK-SLEEVE-FITTING INSTALLATION

- A. Install stack-sleeve fittings in new slabs as slabs are constructed.
1. Install fittings that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
 2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Section 07 62 00 "Sheet Metal Flashing and Trim."
 3. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level.
 4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
 5. Using grout, seal the space around outside of stack-sleeve fittings.
- B. Fire-Barrier Penetrations: Maintain indicated fire rating of floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 07 84 13 "Penetration Firestopping."

3.03 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.

- B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.04 SLEEVE-SEAL-FITTING INSTALLATION

- A. Install sleeve-seal fittings in new walls and slabs as they are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.
- C. Secure nailing flanges to concrete forms.
- D. Using grout, seal the space around outside of sleeve-seal fittings.

3.05 SLEEVE AND SLEEVE-SEAL SCHEDULE

- A. Use sleeves and sleeve seals for the following piping-penetration applications:
 - 1. Exterior Concrete Walls above Grade:
 - a. Piping Smaller Than NPS 6: Cast-iron wall sleeves
 - b. Piping NPS 6 and Larger: Cast-iron wall sleeves
 - 2. Exterior Concrete Walls below Grade:
 - a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
 - b. Piping NPS 6 and Larger: Galvanized-steel-pipe sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
 - 3. Concrete Slabs-on-Grade:
 - a. Piping Smaller Than NPS 6 Galvanized-steel-pipe sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
 - b. Piping NPS 6 and Larger: Galvanized-steel-pipe sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

4. Concrete Slabs above Grade:
 - a. Piping Smaller Than NPS 6 PVC-pipe.
 - b. Piping NPS 6 and Larger: PVC-pipe sleeves.
5. Interior Partitions:
 - a. Piping Smaller Than NPS 6: PVC-pipe sleeves.
 - b. Piping NPS 6 size> and Larger: Galvanized-steel-sheet sleeves.

END OF SECTION 21 05 17

SECTION 21 05 18
ESCUTCHEONS FOR FIRE-SUPPRESSION PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00.
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) requirements.

1.03 SUMMARY

- A. Section Includes:
 - 1. Escutcheons.
 - 2. Floor plates.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

PART 2 - PRODUCTS

2.01 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 hinge, and spring-clip fasteners.

2.02 FLOOR PLATES

- A. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.
- B. Split-Casting Floor Plates: Cast brass with concealed hinge.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.
- B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
 - 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 type with polished, chrome-plated finish.
 - c. Insulated Piping: One-piece, stamped-steel type with concealed hinge.
 - d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge.
 - e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge.
 - f. Bare Piping in Unfinished Service Spaces: One-piece, with polished, chrome-plated finish.
 - g. Bare Piping in Equipment Rooms: One-piece, polished, chrome-plated finish.
 - 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 hinge.
 - c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed hinge.
 - d. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed hinge.
 - e. Bare Piping in Unfinished Service Spaces: Split-plate, stamped-steel type with concealed hinge.
 - f. Bare Piping in Equipment Rooms: Split-plate, stamped-steel type with concealed hinge.
- C. Install floor plates for piping penetrations of equipment-room floors.
- D. 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.

3.02 FIELD QUALITY CONTROL

- A. Replace broken and damaged escutcheons and floor plates using new materials.

END OF SECTION 21 05 18

SECTION 21 05 23
GENERAL-DUTY VALVES FOR WATER-BASED FIRE-SUPPRESSION PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00.
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) requirements.

1.03 SUMMARY

- A. Section Includes:
 - 1. Two-piece ball valves with indicators.
 - 2. Bronze butterfly valves with indicators.
 - 3. Iron butterfly valves with indicators.
 - 4. Check valves.
 - 5. Bronze OS&Y gate valves.
 - 6. Iron OS&Y gate valves.
 - 7. NRS gate valves.
 - 8. Indicator posts.
 - 9. Trim and drain valves.

1.04 DEFINITIONS

- A. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
- B. NRS: Nonrising stem.
- C. OS&Y: Outside screw and yoke.
- D. SBR: Styrene-butadiene rubber.

1.05 ACTION SUBMITTALS

- A. Product Data: For each type of valve.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
 - 1. Protect internal parts against rust and corrosion.
 - 2. Protect threads, flange faces, and weld ends.
 - 3. Set valves open to minimize exposure of functional surfaces.
- B. Use the following precautions during storage:
 - 1. Maintain valve end protection.
 - 2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
- C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use operating handles or stems as lifting or rigging points.
- D. Protect flanges and specialties from moisture and dirt.

PART 2 - PRODUCTS

2.01 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.
 - a) 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.

2.02 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.

2.03 BRONZE BUTTERFLY VALVES WITH INDICATORS

A. Description:

1. Standard: UL 1091 and FM Global standard for indicating valves, (butterfly or ball type), Class Number 1112.
2. Minimum: Pressure rating: 175 psig.
3. Body Material: Bronze.
4. Seat Material: EPDM.
5. Stem Material: Bronze or stainless steel.
6. Disc: Bronze.
7. Actuator: Worm gear or traveling nut.
8. Supervisory Switch: Internal or external.
9. Ends Connections for Valves NPS 1 through NPS 2: Threaded ends.
10. Ends Connections for Valves NPS 2-1/2: Grooved ends.

2.04 IRON BUTTERFLY VALVES WITH INDICATORS

A. Description:

1. Standard: UL 1091 and FM Global standard for indicating valves, (butterfly or ball type), Class Number 112.
2. Minimum Pressure Rating: 175 psig (1200 kPa).
3. Body Material: Cast or ductile iron with nylon coating.
4. Seat Material: EPDM.
5. Stem: Stainless steel.
6. Disc: Ductile iron, nickel plated and EPDM coated.
7. Actuator: Worm gear or traveling nut.
8. Supervisory Switch: Internal or external.
9. Body Design: Lug or wafer.

2.05 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 (1200 kPa).
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.

2.06 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 (1200 kPa).
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.

2.07 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 (1200 kPa).

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.

2.08 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 (1200 kPa).
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.

2.09 INDICATOR POSTS

A. Description:

1. Standard: UL 789 and FM Global standard for indicator posts.
2. Type: Underground.
3. Base Barrel Material: Cast or ductile iron.
4. Extension Barrel: Cast or ductile iron.
5. Cap: Cast or ductile iron.
6. Operation: Handwheel.

2.10 TRIM AND DRAIN VALVES

A. Ball Valves:

1. Description:

- a. Pressure Rating: 175 psig.
- b. Body Design: Two piece.
- c. Body Material: Forged brass or bronze.
- d. Port size: Full or standard.
- e. Seats: PTFE.
- f. Stem: Bronze or stainless steel.
- g. Ball: Chrome-plated brass.
- h. Actuator: Handlever.
- i. End Connections for Valves NPS 1 (DN 25) through NPS 2-1/2 (DN 65): Threaded ends.
- j. End Connections for Valves NPS 1-1/4 and NPS 2-1/2 (DN 32 and DN 65): Grooved ends.

B. Angle Valves:

1. Description:

- a. Pressure Rating: 175 psig (1200 kPa).
- b. Body Material: Brass or bronze.
- c. Ends: Threaded.
- d. Stem: Bronze.
- e. Disc: Bronze.
- f. Packing: Asbestos free.
- g. Handwheel: Malleable iron, bronze, or aluminum.

C. Globe Valves:

1. Description:

- a. Pressure Rating: 175 psig (1200 kPa).
- b. Body Material: Bronze with integral seat and screw-in bonnet.
- c. Ends: Threaded.

- d. Stem: Bronze.
- e. Disc Holder and Nut: Bronze.
- f. Disc Seat: Nitrile.
- g. Packing: Asbestos free.
- h. Handwheel: Malleable iron, bronze, or aluminum.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- E. Do not attempt to repair defective valves; replace with new valves.

3.02 GENERAL REQUIREMENTS FOR VALVE INSTALLATION

- A. Comply with requirements in the following Sections for specific valve installation requirements and applications:
 - 1. Section 21 13 13 “Wet-Pipe Sprinkler Systems” for application of valves in wet-pipe, fire-suppression sprinkler systems.
 - 2. Section 21 13 16 “Pre-Action-Pipe Sprinkler Systems” for application of valves in dry-pipe, fire-suppression sprinkler systems.
- B. Install listed fire-protection shutoff valves supervised-open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.
- C. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.
- D. Install valves having threaded connections with unions at each piece of equipment arranged to allow easy access, service, maintenance, and equipment removal without system shutdown. Provide separate support where necessary.
- E. Install valves in horizontal piping with stem at or above the pipe center.
- F. Install valves in position to allow full stem movement.

- G. Install valve tags. Comply with requirements in Section 21 05 53 “Identification for Fire-Suppression Piping and Equipment” for valve tags and schedules and signs on surfaces concealing valves; and the NFPA standard applying to the piping system in which valves are installed. Install permanent identification signs indicating the portion of system controlled by each valve.
- H. Install listed fire-protection shutoff valves supervised-open, located to control sources of water supply except from fire-department connections.
- I. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.

END OF SECTION 21 05 23

SECTION 21 05 53
IDENTIFICATION FOR FIRE-SUPPRESSION PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00.
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) requirements.

1.03 SUMMARY

- A. Section Includes:
 - 1. Equipment labels.
 - 2. Warning signs and labels.
 - 3. Pipe labels.
 - 4. Stencils.
 - 5. Valve tags.
 - 6. Warning tags.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For color, letter style, and graphic representation required for each identification material and device.
- C. Equipment-Label Schedule: Include a listing of all equipment to be labeled and the proposed content for each label.
- D. Valve Schedules: Valve numbering scheme.

PART 2 - PRODUCTS

2.01 EQUIPMENT LABELS

- A. Metal Labels for Equipment:

1. Material and Thickness: stainless steel, 0.025-inch-thick, with predrilled holes for attachment hardware.
2. Letter Color: White.
3. Background Color: Red.
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-fourths the size of principal lettering.
6. Fasteners: Stainless-steel rivets.
7. 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, 1/16 inch thick, with predrilled holes for attachment hardware.
2. Letter Color: White
3. Background Color: Red.
4. Maximum Temperature: Able to withstand temperatures up to 160°F.
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
6. 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.
7. Fasteners: Stainless-steel rivets.
8. 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.

2.02 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: Red.
- D. Maximum Temperature: Able to withstand temperatures up to 160°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 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.

2.03 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 partially cover 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.
- E. Pipe-Label Colors:
 - 1. Background Color: Safety Red.
 - 2. Letter Color: White.

2.04 STENCILS

A. Stencils for Piping:

1. Lettering Size: Size letters according to ASME A13.1 for piping.
2. Stencil Material: Aluminum.
3. Stencil Paint: Safety Red, exterior, gloss, acrylic enamel. Paint may be in pressurized spray-can form.
4. Identification Paint: White, exterior, acrylic enamel. Paint may be in pressurized spray-can form.

2.05 VALVE TAGS

A. Description: Stamped or engraved with 1/4-inch letters for piping-system abbreviation and 1/2-inch numbers.

1. Tag Material: stainless steel, 0.025-inch-thick, with predrilled holes for attachment hardware.
2. Fasteners: Brass wire-link chain.
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.

1. Valve-tag schedule shall be included in operation and maintenance data.

2.06 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 minimum.
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.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Clean piping and equipment surfaces of incompatible primers, paints, and encapsulants, as well as dirt, oil, grease, release agents, and other substances that could impair bond of identification devices.

3.02 GENERAL INSTALLATION REQUIREMENTS

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be installed.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

3.03 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

3.04 PIPE LABEL INSTALLATION

- A. Piping: Painting of piping is specified in Section 09 91 23 "Interior Painting.
- B. 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 on each piping system.
 - 1. Identification Paint: Use for contrasting background.
 - 2. Stencil Paint: Use for pipe marking.
- C. Pipe-Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 - 1. Near each valve and control device.
 - 2. Near each branch connection excluding short takeoffs. Where flow pattern is not obvious, mark each pipe at branch.
 - 3. Near penetrations and on through walls, floors, ceilings, and inaccessible enclosures.
 - 4. At access doors, manholes, and similar access points that permit a view of concealed piping.
 - 5. Near major equipment items and other points of origination and termination.

6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
 7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.
- D. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes including pipes where flow is allowed in both directions.

3.05 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in fire-suppression piping systems. List tagged valves in a valve-tag schedule.
- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and with captions similar to those indicated in “Valve-Tag Size and Shape” Subparagraph below:
 1. Valve-Tag Size and Shape:
 - a. Fire-Suppression Standpipe: 2 inches, round.
 - b. Wet-Pipe Sprinkler System: 2 inches, round.
 - c. Pre-Action-Pipe Sprinkler System: 2 inches, round.
 - d. Clean-Agent Fire-Extinguishing System: 2 inches, round.

3.06 WARNING-TAG INSTALLATION

- A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION 21 05 53

SECTION 21 11 19
FIRE-DEPARTMENT CONNECTIONS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00.
 - 1. Refer to "PART 2 – PRODUCTS" for all Buy America Build America Act (BABA) requirements.

1.03 SUMMARY

- A. Section Includes:
 - 1. Yard-type fire-department connections.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each fire-department connection.

PART 2 - PRODUCTS

2.01 YARD-TYPE FIRE-DEPARTMENT CONNECTION

- A. Standard: UL 405.
- B. Type: Exposed, freestanding.
- 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: Round, brass, floor type.
- H. Outlet: Bottom, with pipe threads.
- I. Number of Inlets: Two.

- J. Sleeve: Galvanized Steel.
- K. Sleeve Height: 2 inches.
- L. Escutcheon Plate Marking: Similar to "AUTO SPKR."
- M. Finish: Polished chrome plated.
- N. Outlet Size: NPS 4

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of fire-department connections.
- B. Examine roughing-in for fire-suppression standpipe system to verify actual locations of piping connections before fire-department connection installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Install yard-type fire-department connections in concrete slab support. Comply with requirements for concrete in Section 03 30 00 "Cast-in-Place Concrete."
- B. Install three protective pipe bollards around each fire-department connection. Comply with requirements for bollards in Section 05 50 00 "Metal Fabrications."
- C. Install automatic (ball-drip) drain valve at each check valve for fire-department connection.

END OF SECTION 21 11 19

SECTION 21 13 13
WET-PIPE SPRINKLER SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00.
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) requirements.

1.03 SUMMARY

- A. Section Includes:
 - 1. Pipes, fittings, and specialties.
 - 2. Cover system for sprinkler piping.
 - 3. Specialty valves.
 - 4. Sprinklers.
 - 5. Alarm devices.
 - 6. Manual control stations.
 - 7. Control panels.
 - 8. Pressure gages.
- B. Related Requirements:
 - 1. Section 21 11 19 “Fire Department Connections” for exposed-, flush-, and yard-type fire department connections.
 - 2. Section 21 05 23 “General-Duty Valves for Water-Based Fire-Suppression Piping” for ball, butterfly, check, gate, post-indicator, and trim and drain valves.

1.04 DEFINITIONS

- A. Standard-Pressure Sprinkler Piping: Wet-pipe sprinkler system piping designed to operate at working pressure of 175-psig maximum.

1.05 ACTION SUBMITTALS

- A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For wet-pipe sprinkler systems.
1. Include plans, elevations, sections, and attachment details.
 2. Include diagrams for power, signal, and control wiring.

1.06 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Sprinkler systems, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
1. Domestic water piping.
 2. Compressed air piping.
 3. HVAC hydronic piping.
 4. Items penetrating finished ceiling include the following:
 - a. Lighting fixtures.
 - b. Air outlets and inlets.
- B. Qualification Data: For qualified Installer and professional engineer registered in the State of Florida.
- C. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations if applicable.
- D. Welding certificates.
- E. Fire-hydrant flow test report.
- F. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include “Contractor’s Material and Test Certificate for Aboveground Piping.”
- G. Field quality-control reports.

1.07 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For wet-pipe sprinkler systems and specialties to include in emergency, operation, and maintenance manuals.

1.08 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Sprinkler Cabinets: 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.

1.09 QUALITY ASSURANCE

A. Installer Qualifications:

1. Installer's responsibilities include designing, fabricating, and installing sprinkler systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.
 - a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer.

B. Welding Qualifications: Qualify procedures and operators according to 2010 ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with the following:

1. NFPA 13.

B. Standard-Pressure Piping System Component: Listed for 175-psig minimum working pressure.

1. 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:
 - 1) Building Service Areas: Ordinary Hazard, Group 1
 - 2) Electrical Equipment Rooms: Ordinary Hazard, Group 1
 - 3) General Storage Areas: Ordinary Hazard, Group 1
 - 4) Mechanical Equipment Rooms: Ordinary Hazard, Group 1
 - 5) Office and Public Areas: Light Hazard
2. Minimum Density for Automatic-Sprinkler Piping Design:
 - a. Light-Hazard Occupancy: 0.10 gpm over 1500-sq. ft. area.
 - b. Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm over 1500-sq. ft. area.
 - c. Ordinary-Hazard, Group 2 Occupancy: 0.20 gpm over 1500-sq. ft. area.
 - d. Extra-Hazard, Group 1 Occupancy: 0.30 gpm over 2500-sq. ft. area.

3. Maximum Protection Area per Sprinkler: According to UL listing.
4. Maximum Protection Area per Sprinkler:
 - a. Office Spaces: 225 sq. ft.
 - b. Storage Areas: 130 sq. ft.
 - c. Mechanical Equipment Rooms: 130 sq. ft.
 - d. Electrical Equipment Rooms: 130 sq. ft.
 - e. Other Areas: According to NFPA 13 recommendations unless otherwise indicated.
- C. Seismic Performance: Sprinkler piping shall withstand the effects of earthquake motions determined according to NFPA 13.

2.02 STEEL PIPE AND FITTINGS

- A. Schedule 40, Galvanized and Black Steel Pipe: ASTM A 135/A 135M; ASTM A 795/A 795M, Type E; or ASME B36.10M wrought steel. Pipe ends may be factory or field formed to match joining method.
- B. Schedule 10, Black-Steel Pipe: ASTM A 135/A 135M or ASTM A 795/A 795M, Schedule 10 in NPS 5 and smaller; and NFPA 13-specified wall thickness in NPS 6 to NPS 10, plain end.
- C. Galvanized and Black Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M, standard-weight, seamless steel pipe with threaded ends.
- D. Galvanized and Uncoated-Steel Couplings: ASTM A 865/A 865M, threaded.
- E. Galvanized, Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.
- F. Malleable- or Ductile-Iron Unions: UL 860.
- G. Cast-Iron Flanges: ASME 16.1, Class 125.
- H. Steel Flanges and Flanged Fittings: ASME B16.5, Class 150.
 1. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch thick.
 - a. Class 125 and Class 250, Cast-Iron, Flat-Face Flanges: Full-face gaskets.
 - b. Class 150 and Class 300, Ductile-Iron or -Steel, Raised-Face Flanges: Ring-type gaskets.
 2. Metal, Pipe-Flange Bolts and Nuts: Carbon steel unless otherwise indicated.
- I. Steel Welding Fittings: ASTM A 234/A 234M and ASME B16.9.
 1. 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.

- J. Grooved-Joint, Steel-Pipe Appurtenances:
 1. Pressure Rating: 175-psig minimum.
 2. Galvanized Grooved-End Fittings for Steel Piping: ASTM A 47/A 47M, malleable-iron casting or ASTM A 536, ductile-iron casting, with dimensions matching steel pipe.
 3. 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.
- K. 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.

2.03 COPPER TUBE AND FITTINGS

- A. Hard Copper Tube: ASTM B 88, Type L and ASTM B 88, Type M water tube, drawn temper.
- B. Cast-Copper, Solder-Joint Fittings: ASME B16.18 pressure fittings.
- C. Wrought-Copper, Solder-Joint Fittings: ASME B16.22 pressure fittings.
- D. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.
- E. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
- F. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces and solder-joint or threaded ends.
- G. Copper Pressure-Seal Fittings:
 1. Standard: UL 213.
 2. NPS 2 and Smaller: Wrought-copper fitting with EPDM-rubber O-ring seal in each end.
 3. NPS 2-1/2 to NPS 4 : Cast-bronze fitting with EPDM-rubber O-ring seal in each end.
- H. Grooved-Joint, Copper-Tube Appurtenances:
 1. Grooved-End Copper Fittings: ASTM B 75 copper tube or ASTM B 584 bronze castings.
 2. Grooved-End-Tube Couplings: To fit copper-tube dimensions, with design similar to AWWA C606. Include ferrous housing sections, EPDM-rubber gasket suitable for hot and cold water, and bolts and nuts.
- I. Copper-Tube, Extruded-Tee Connections:

1. Description: Tee formed in copper tube according to ASTM F 2104.

2.04 SPECIALTY VALVES

- A. Listed in UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."
- B. Pressure Rating:
 1. Standard-Pressure Piping Specialty Valves: 175-psig minimum.
 2. High-Pressure Piping Specialty Valves: 250-psig minimum.
- C. Body Material: Cast or ductile iron.
- D. Size: Same as connected piping.
- E. End Connections: Flanged or grooved.
- F. Alarm Valves:
 1. Standard: UL 193.
 2. Design: For horizontal or vertical installation.
 3. Include trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gages, retarding chamber and fill-line attachment with strainer.
 4. Drip Cup Assembly: Pipe drain without valves and separate from main drain piping.
 5. Drip Cup Assembly: Pipe drain with check valve to main drain piping.
 6. 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
- G. Deluge Valves:
 1. Standard: UL 260.
 2. Design: Hydraulically operated, differential-pressure type.
 3. Include trim sets for alarm-test bypass, drain, electrical water-flow alarm switch, pressure gages, drip cup assembly piped without valves and separate from main drain line, and fill-line attachment with strainer.
 4. Wet, Pilot-Line Trim Set: Include gage to read diaphragm-chamber pressure and manual control station for manual operation of deluge valve, and connection for actuation device.
- H. Automatic (Ball Drip) Drain Valves:
 1. Standard: UL 1726.
 2. Pressure Rating: 175-psig minimum.

3. Type: Automatic draining, ball check.
4. Size: NPS 3/4 .
5. End Connections: Threaded.

2.05 SPRINKLER PIPING SPECIALTIES

A. Branch Outlet Fittings:

1. Standard: UL 213.
2. Pressure Rating: 175-psig minimum.
3. Body Material: Ductile-iron housing with EPDM seals and bolts and nuts.
4. Type: Mechanical-tee and -cross fittings.
5. Configurations: Snap-on and strapless, ductile-iron housing with branch outlets.
6. Size: Of dimension to fit onto sprinkler main and with outlet connections as required to match connected branch piping.
7. Branch Outlets: Grooved, plain-end pipe, or threaded.

B. Flow Detection and Test Assemblies:

1. Standard: UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."
2. Pressure Rating: 175-psig minimum.
3. Body Material: Cast- or ductile-iron housing with orifice, sight glass, and integral test valve.
4. Size: Same as connected piping.
5. Inlet and Outlet: Threaded or grooved.

C. Branch Line Testers:

1. Standard: UL 199.
2. Pressure Rating: 175 psig .
3. Body Material: Brass.
4. Size: Same as connected piping.
5. Inlet: Threaded.
6. Drain Outlet: Threaded and capped.
7. Branch Outlet: Threaded, for sprinkler.

- D. Sprinkler Inspector's Test Fittings:
 - 1. Standard: UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."
 - 2. Pressure Rating: 175-psig minimum.
 - 3. Body Material: Cast- or ductile-iron housing with sight glass.
 - 4. Size: Same as connected piping.
 - 5. Inlet and Outlet: Threaded.
- E. Adjustable Drop Nipples:
 - 1. Standard: UL 1474.
 - 2. Pressure Rating: 250-psig minimum.
 - 3. Body Material: Steel pipe with EPDM-rubber O-ring seals.
 - 4. Size: Same as connected piping.
 - 5. Length: Adjustable.
 - 6. Inlet and Outlet: Threaded.
- F. Flexible Sprinkler Hose Fittings:
 - 1. Standard: UL 1474.
 - 2. Type: Flexible hose for connection to sprinkler, and with bracket for connection to ceiling grid.
 - 3. Pressure Rating: 175-psig minimum.
 - 4. Size: Same as connected piping, for sprinkler.

2.06 SPRINKLERS

- A. Listed in UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."
- B. Pressure Rating for Automatic Sprinklers: 175-psig minimum.
 - 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.
- C. Sprinkler Finishes: Chrome plated, bronze, and painted.
- D. 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: Aluminum white finish, one piece, flat.

2. Sidewall Mounting: Aluminum, white finish, one piece, flat.

E. Sprinkler Guards:

1. Standard: UL 199.

2. Type: Wire cage with fastening device for attaching to sprinkler.

2.07 ALARM DEVICES

A. Alarm-device types shall match piping and equipment connections.

B. Electrically Operated Alarm Bell:

1. Standard: UL 464.

2. Type: Vibrating, metal alarm bell.

3. Size: 6-inch diameter.

4. Finish: Red-enamel factory finish, suitable for outdoor use.

5. 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

C. Water-Flow Indicators:

1. Standard: UL 346.

2. Water-Flow Detector: Electrically supervised.

3. 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.

4. Type: Paddle operated.

5. Pressure Rating: 250 psig .

6. Design Installation: Horizontal or vertical.

D. Pressure Switches:

1. Standard: UL 346.

2. Type: Electrically supervised water-flow switch with retard feature.

3. Components: Single-pole, double-throw switch with normally closed contacts.

4. Design Operation: Rising pressure signals water flow.

E. Valve Supervisory Switches:

1. Standard: UL 346.
2. Type: Electrically supervised.
3. Components: Single-pole, double-throw switch with normally closed contacts.
4. Design: Signals that controlled valve is in other than fully open position.
5. 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

2.08 MANUAL CONTROL STATIONS

- A. Listed in UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide" for hydraulic operation, with union, NPS 1/2 pipe nipple, and bronze ball valve.
- B. Include metal enclosure labeled "MANUAL CONTROL STATION," with operating instructions and cover held closed by breakable strut to prevent accidental opening.

2.09 CONTROL PANELS

- A. Description: Single-area, two-area, or single-area cross-zoned control panel as indicated, including NEMA ICS 6, Type 1 enclosure, detector, alarm, and solenoid-valve circuitry for operation of deluge valves.
 1. Listed in UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide" when used with thermal detectors and Class A detector circuit wiring.
 2. Electrical characteristics are 120-V ac, 60 Hz, with 24-V dc rechargeable batteries.
 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
- B. Manual Control Stations: Electric operation, metal enclosure, labeled "MANUAL CONTROL STATION," with operating instructions and cover held closed by breakable strut to prevent accidental opening.
- C. Panels Components:
 1. Power supply.
 2. Battery charger.
 3. Standby batteries.
 4. Field-wiring terminal strip.
 5. Electrically supervised solenoid valves and polarized fire-alarm bell.
 6. Lamp test facility.
 7. Single-pole, double-throw auxiliary alarm contacts.

8. Rectifier.

2.10 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.
- D. Label: Include “WATER” label on dial face.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Perform fire-hydrant flow test according to NFPA 13 and NFPA 291. Use results for system design calculations required in “Quality Assurance” Article.
- B. Report test results promptly and in writing.

3.02 SERVICE-ENTRANCE PIPING

- A. Install shutoff valve, pressure gage, drain, and other accessories indicated at connection to water-service piping.
- B. Install shutoff valve, check valve, pressure gage, and drain at connection to water service.

3.03 WATER-SUPPLY CONNECTIONS

- A. Install shutoff valve, check valve, pressure gage, and drain at connection to water supply.

3.04 PIPING INSTALLATION

- A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated on approved working plans.
 - 1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect-Engineer before deviating from approved working plans.
 - 2. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.
- B. Piping Standard: Comply with NFPA 13 requirements for installation of sprinkler piping.
- C. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
- D. Install unions adjacent to each valve in pipes NPS 2 and smaller.
- E. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.

- F. Install “Inspector's Test Connections” in sprinkler system piping, complete with shutoff valve, and sized and located according to NFPA 13.
- G. Install sprinkler piping with drains for complete system drainage.
- H. Install sprinkler control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.
- I. Install automatic (ball drip) drain valve at each check valve for fire-department connection, to drain piping between fire-department connection and check valve. Install drain piping to and spill over floor drain or to outside building.
- J. Install alarm devices in piping systems.
- K. Install pressure gages on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gages with connection not less than NPS 1/4 and with soft-metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they are not subject to freezing.
- L. Pressurize and check preaction sprinkler system piping and air-pressure maintenance devices.
- M. Fill sprinkler system piping with water.
- N. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 21 05 17 “Sleeves and Sleeve Seals for Fire-Suppression Piping.”
- O. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 21 05 17 “Sleeves and Sleeve Seals for Fire-Suppression Piping.”
- P. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 21 05 18 “Escutcheons for Fire-Suppression Piping.”

3.05 JOINT CONSTRUCTION

- A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.
- B. Install unions adjacent to each valve in pipes NPS 2 and smaller.
- C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.
- D. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- E. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- F. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.

- G. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
1. Apply appropriate tape or thread compound to external pipe threads.
 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- H. Twist-Locked Joints: Insert plain end of steel pipe into plain-end-pipe fitting. Rotate retainer lugs one-quarter turn or tighten retainer pin.
- I. Steel-Piping, Pressure-Sealed Joints: Join lightwall steel pipe and steel pressure-seal fittings with tools recommended by fitting manufacturer.
- J. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to “Quality Assurance” Article.
1. Shop weld pipe joints where welded piping is indicated. Do not use welded joints for galvanized-steel pipe.
- K. Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe joints.
- L. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.
- M. Steel-Piping, Pressure-Sealed Joints: Join Schedule 5 steel pipe and steel pressure-seal fittings with tools recommended by fitting manufacturer.
- N. Brazed Joints: Join copper tube and fittings according to CDA’s “Copper Tube Handbook,” “Braze Joints” Chapter.
- O. Copper-Tubing Grooved Joints: Roll rounded-edge groove in end of tube according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join copper tube and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.
- P. Copper-Tubing, Pressure-Sealed Joints: Join copper tube and copper pressure-seal fittings with tools recommended by fitting manufacturer.
- Q. Extruded-Tee Connections: Form tee in copper tube according to ASTM F 2014. Use tool designed for copper tube; drill pilot hole, form collar for outlet, dimple tube to form seating stop, and braze branch tube into collar.
- R. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.
- S. Plastic-Piping, Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements. Apply primer.

2. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.

3.06 VALVE AND SPECIALTIES INSTALLATION

- A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 13 and authorities having jurisdiction.
- B. Install listed fire-protection shutoff valves supervised open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.
- C. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.
- D. Specialty Valves:
 1. Install valves in vertical position for proper direction of flow, in main supply to system.
 2. Install alarm valves with bypass check valve and retarding chamber drain-line connection.
 3. Install deluge valves in vertical position, in proper direction of flow, and in main supply to deluge system. Install trim sets for drain, priming level, alarm connections, ball drip valves, pressure gages, priming chamber attachment, and fill-line attachment.

3.07 SPRINKLER INSTALLATION

- A. Install sprinklers in suspended ceilings in center of acoustical ceiling panels.
- B. Install sprinklers into flexible, sprinkler hose fittings, and install hose into bracket on ceiling grid.

3.08 IDENTIFICATION

- A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.
- B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.09 FIELD QUALITY CONTROL

- 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.
- C. Prepare test and inspection reports.

3.10 CLEANING

- A. Clean dirt and debris from sprinklers.
- B. Only sprinklers with their original factory finish are acceptable. Remove and replace any sprinklers that are painted or have any other finish than their original factory finish.

3.11 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain specialty valves and pressure-maintenance pumps.

3.12 PIPING SCHEDULE

- A. Piping between Fire Department Connections and Check Valves: Galvanized, standard-weight steel pipe with grooved ends, grooved-end fittings, grooved-end-pipe couplings, and grooved joints.
- B. Sprinkler specialty fittings may be used, downstream of control valves, instead of specified fittings.
- C. Copper-tube, extruded-tee connections may be used for tee branches in copper tubing instead of specified copper fittings. Branch-connection joints must be brazed.
- D. Standard-pressure, wet-pipe sprinkler system, NPS 2 and smaller, shall be one of the following:
 1. Schedule 40, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
 2. Schedule 40, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.
 3. Schedule 40, black-steel pipe with plain ends; uncoated, plain-end-pipe fittings; and twist-locked joints.
 4. Schedule 40, galvanized-steel pipe with plain ends; galvanized, plain-end-pipe fittings; and twist-locked joints.

5. Schedule 40, black-steel pipe with cut or roll grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
 6. Schedule 40, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
 7. Schedule 40, black-steel pipe with plain ends; steel welding fittings; and welded joints.
- E. Standard-pressure, wet-pipe sprinkler system, NPS 2-1/2 to NPS 6, shall be the following:
1. Schedule 10 black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

3.13 SPRINKLER SCHEDULE

- A. Use sprinkler types in subparagraphs below for the following applications:
1. Rooms without Ceilings: Upright sprinklers.
 2. Rooms with Suspended Ceilings: Recessed, and concealed sprinklers as indicated on plans.
 3. Wall Mounting: Sidewall sprinklers.
 4. Special Applications: Extended-coverage where indicated
- B. Provide sprinkler types in subparagraphs below with finishes indicated.
1. Concealed Sprinklers: Rough brass, with factory-painted white cover plate.
 2. Recessed Sprinklers: Bright chrome, with bright chrome escutcheon.
 3. Upright Sprinklers: Rough bronze in unfinished spaces not exposed to view; wax coated where exposed to acids, chemicals, or other corrosive fumes.

END OF SECTION 21 13 13

SECTION 21 13 16
PRE-ACTION SPRINKLER SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00.
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) requirements.

1.03 SUMMARY

- A. Section Includes:
 - 1. Pipes, fittings, and specialties.
 - 2. Specialty valves.
 - 3. Sprinkler specialty pipe fittings.
 - 4. Sprinklers.
 - 5. Alarm devices.
 - 6. Manual control stations.
 - 7. Control panels.
 - 8. Pressure gages.
- B. Related Requirements:
 - 1. Section 21 11 19 “Fire Department Connections” for exposed-, flush-, and yard-type fire department connections.
 - 2. Section 21 05 23 “General-Duty Valves for Water-Based Fire-Suppression Piping” for ball, butterfly, check, gate, post-indicator, and trim and drain valves.

1.04 DEFINITIONS

- A. Standard-Pressure Sprinkler Piping: Pre-action sprinkler system piping designed to operate at working pressure of 175-psig maximum.

1.05 ACTION SUBMITTALS

- A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For Pre-action sprinkler systems.
1. Include plans, elevations, sections, and attachment details.
 2. Include diagrams for power, signal, and control wiring.

1.06 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Sprinkler systems, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
1. Domestic water piping.
 2. HVAC hydronic piping.
 3. HVAC ductwork
 4. Data and Electrical equipment and wiring
 5. Items penetrating finished ceiling including the following:
 - a. Lighting fixtures.
 - b. Air outlets and inlets.
- B. Qualification Data: For qualified Installer.
- C. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations as a confirmation of the Architect-Engineer's calculations. Base calculations on results of fire-hydrant flow test.
- D. Fire-hydrant flow test report.
- E. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include "Contractor's Material and Test Certificate for Aboveground Piping."
- F. Field quality-control reports.

1.07 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For pre-action sprinkler systems and specialties to include in emergency, operation, and maintenance manuals.

1.08 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Sprinkler Cabinets: 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.

1.09 QUALITY ASSURANCE

A. Installer Qualifications:

1. Installer's responsibilities include planning, coordinating, fabricating, and installing sprinkler systems.

1.10 WORK INCLUDED

- A. This section covers equipment, installation, testing and all materials required for the dry-pipe pre-action fire sprinkler protection packaged system, single interlock with electric/electric release. All equipment shall be housed in a pre-assembled and a free standing cabinet.
- B. Contractor shall be responsible for the complete system planning, coordination, layout, hydraulic calculations (to confirm Architect-Engineer's calculations), preparation of shop drawings, field installation, coordination and completion in accordance with project requirements and applicable codes and standards.
- C. Work or equipment not indicated or specified which is necessary for the complete and proper operation of the work of this section in accordance with the true intent and meaning of the contract documents shall be provided by this Contractor and incorporated under this section of the work at no additional cost to the owner.

1.11 WARRANTY

- A. Warranty: Repair or replace components that fail in materials or workmanship. Manufacturer's warranty shall be in the name of the Owner.
 1. Warranty Period: One year minimum from date of Substantial Completion, or longer if standard manufacturer's warranty is longer.

PART 2 - PRODUCTS

2.01 SYSTEM DESCRIPTIONS

- A. Single-Interlock Pre-Action Sprinkler System: System to provide coverage for rooms as indicated on drawings. The method of release of the deluge valve priming water pressure shall be by an electric solenoid valve and a electric actuator. The pre-action system riser shall be of a listed and approved assembly. The system riser shall be equipped with a rubber seated check valve downstream of the deluge valve and prior to the supervisory air connection. Automatic sprinklers are attached to piping containing low-pressure air. Actuation of a fire-detection system, located in same area as sprinklers, opens deluge valve, permitting water to flow into sprinkler piping. Water will then discharge from opened sprinklers. The pre-action system shall be provided with all necessary appurtenances to complete the system. The system shall be installed in conformance with the current Edition of N.F.P.A. 13, Standard for Installation of Sprinkler Systems.

- B. Interface system with building fire and smoke alarm system. The fire alarm system shall monitor the pre-action system. Refer to specification section 28 31 11 and coordinate.
- C. Provide system to hazard occupancy classification required by the authority having jurisdiction.

2.02 PERFORMANCE REQUIREMENTS

- A. Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with the following:
 - 1. NFPA 13.
- B. Standard-Pressure Piping System Component: Listed for 175-psig minimum working pressure.
- C. Sprinkler system design shall be approved by authorities having jurisdiction.
 - 1. Margin of Safety for Available Water Flow and Pressure: 10 percent, including losses through water-service piping, valves, and backflow preventers.
 - 2. Sprinkler Occupancy Hazard Classifications:
 - a. Data Equipment Rooms: Ordinary Hazard, Group 1
 - 3. Minimum Density for Automatic-Sprinkler Piping Design:
 - a. Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm over 1500-sq. ft. area.
 - 4. Maximum Protection Area per Sprinkler: According to UL listing.
 - 5. Maximum Protection Area per Sprinkler:
 - a. Data Equipment Rooms: 130 sq. ft. .
 - 6. Total Combined Hose-Stream Demand Requirement: According to NFPA 13 unless otherwise indicated:
 - a. Ordinary-Hazard Occupancies: 250 gpm for 60 minutes.

2.03 STEEL PIPE AND FITTINGS

- A. Schedule 40, Galvanized-Steel Pipe: ASTM A 135/A 135M; ASTM A 795/A 795M, Type E or ASME B36.10M wrought steel. Pipe ends may be factory or field formed to match joining method.
- B. Galvanized-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M, standard-weight, seamless steel pipe with threaded ends.
- C. Galvanized-Steel Couplings: ASTM A 865/A 865M, threaded.
- D. Galvanized, Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.
- E. Malleable- or Ductile-Iron Unions: UL 860.

- F. Cast-Iron Flanges: ASME B16.1, Class 125.
- G. Plain-End-Pipe Fittings: UL 213, ductile-iron body with retainer lugs that require one-quarter turn or screwed retainer pin to secure pipe in fitting.
- H. Grooved-Joint, Steel-Pipe Appurtenances:
 - 1. Pressure Rating: 175-psig minimum.
 - 2. Galvanized, Grooved-End Fittings for Steel Piping: ASTM A 47/A 47M, malleable-iron casting or ASTM A 536, ductile-iron casting, with dimensions matching steel pipe.
 - 3. 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.

2.04 COPPER TUBE AND FITTINGS

- A. Hard Copper Tube: ASTM B 88, Type L and ASTM B 88, Type M water tube, drawn temper.
- B. Cast-Copper, Solder-Joint Fittings: ASME B16.18 pressure fittings.
- C. Wrought-Copper, Solder-Joint Fittings: ASME B16.22 pressure fittings.
- D. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.
- E. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
 - 1. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch thick.
- F. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces and solder-joint or threaded ends.
- G. Copper Pressure-Seal Fittings:
 - 1. Standard: UL 213.
 - 2. NPS 2 and Smaller: Wrought-copper fitting with EPDM-rubber O-ring seal in each end.
 - 3. NPS 2-1/2 to NPS 4 : Cast-bronze fitting with EPDM-rubber O-ring seal in each end.
- H. Grooved-Joint, Copper-Tube Appurtenances:
 - 1. Grooved-End Copper Fittings: ASTM B 75 , copper tube or ASTM B 584 bronze castings.
 - 2. Grooved-End-Tube Couplings: To fit copper-tube dimensions, with design similar to AWWA C606. Include ferrous housing sections, EPDM-rubber gasket suitable for hot and cold water, and bolts and nuts.

I. Copper-Tube, Extruded-Tee Connections:

1. Description: Tee formed in copper tube according to ASTM F 2104.

2.05 SPECIALTY VALVES

A. Listed in UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."

B. Pressure Rating:

1. Standard-Pressure Piping Specialty Valves: 175-psig minimum.

C. Body Material: Cast or ductile iron.

D. Size: Same as connected piping.

E. End Connections: Flanged or grooved.

F. Pre-action Valves:

1. Standard: UL 260.

2. Design: Differential-pressure type.

3. Include UL 1486, quick-opening devices, trim sets for air supply, drain, priming level, alarm connections, ball drip valves, pressure gages, priming chamber attachment, and fill-line attachment.

4. Air-Pressure Maintenance Device:

5. Standard: UL 260.

6. Type: Automatic device to maintain minimum air pressure in piping.

7. Include shutoff valves to permit servicing without shutting down sprinkler piping, bypass valve for quick filling, pressure regulator or switch to maintain pressure, strainer, pressure ratings with 14- to 60-psig adjustable range, and 175-psig 300-psig outlet pressure.

8. Air Compressor:

- a. Standard: UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."

- b. Motor Horsepower: Fractional.

- c. Power: 120-V ac, 60 Hz, single phase.

G. Deluge Valves:

1. Standard: UL 260.

2. Design: Hydraulically operated, differential-pressure type.

3. Include trim sets for alarm-test bypass, drain, electrical water-flow alarm switch, pressure gages, drip cup assembly piped without valves and separate from main drain line, and fill-line attachment with strainer.
4. Dry, Pilot-Line Trim Set: Include dry, pilot-line actuator; air- and water-pressure gages; low-air-pressure warning switch; air relief valve; and actuation device. Dry, pilot-line actuator includes cast-iron, operated, diaphragm-type valve with resilient facing plate, resilient diaphragm, and replaceable bronze seat. Valve includes threaded water and air inlets and water outlet. Loss of air pressure on dry, pilot-line side allows pilot-line actuator to open and causes deluge valve to open immediately.
5. Air-Pressure Maintenance Device:
 - a. Standard: UL 260.
 - b. Type: Automatic device to maintain minimum air pressure in piping.
 - c. Include shutoff valves to permit servicing without shutting down sprinkler piping, bypass valve for quick filling, pressure regulator or switch to maintain pressure, strainer, pressure ratings with 14- to 60-psig adjustable range, and 175-psig outlet pressure.
6. Air Compressor:
 - a. Standard: UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."
 - b. Motor Horsepower: Fractional.
 - c. Power: 120-V ac, 60 Hz, single phase.
 - d. 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

H. Automatic (Ball Drip) Drain Valves:

1. Standard: UL 1726.
2. Pressure Rating: 175-psig minimum.
3. Type: Automatic draining, ball check.
4. Size: NPS 3/4 .
5. End Connections: Threaded.

2.06 SPRINKLER PIPING SPECIALTIES

- A. General Requirements for Pre-action System Fittings: UL listed for pre-action service.
- B. Branch Outlet Fittings:

1. Standard: UL 213.
2. Pressure Rating: 175-psig minimum.
3. Body Material: Ductile-iron housing with EPDM seals and bolts and nuts.
4. Type: Mechanical-tee and -cross fittings.
5. Configurations: Snap-on and strapless, ductile-iron housing with branch outlets.
6. Size: Of dimension to fit onto sprinkler main and with outlet connections as required to match connected branch piping.
7. Branch Outlets: Grooved, plain-end pipe, or threaded.

C. Flow Detection and Test Assemblies:

1. Standard: UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."
2. Pressure Rating: 175-psig minimum.
3. Body Material: Cast- or ductile-iron housing with orifice, sight glass, and integral test valve.
4. Size: Same as connected piping.
5. Inlet and Outlet: Threaded.

D. Branch Line Testers:

1. Standard: UL 199.
2. Pressure Rating: 175-psig minimum.
3. Body Material: Brass.
4. Size: Same as connected piping.
5. Inlet: Threaded.
6. Drain Outlet: Threaded and capped.
7. Branch Outlet: Threaded, for sprinkler.

E. Sprinkler Inspector's Test Fittings:

1. Standard: UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."
2. Pressure Rating: 175-psig minimum.
3. Body Material: Cast- or ductile-iron housing with sight glass.
4. Size: Same as connected piping.

5. Inlet and Outlet: Threaded.
- F. Adjustable Drop Nipples:
1. Standard: UL 1474.
 2. Pressure Rating: 250-psig minimum 300 psig.
 3. Body Material: Steel pipe with EPDM O-ring seals.
 4. Size: Same as connected piping.
 5. Length: Adjustable.
 6. Inlet and Outlet: Threaded.
- G. Flexible Sprinkler Hose Fittings:
1. Standard: UL 1474.
 2. Type: Flexible hose for connection to sprinkler, and with bracket for connection to ceiling grid.
 3. Pressure Rating: 175-psig minimum.
 4. Size: Same as connected piping, for sprinkler.

2.07 SPRINKLERS

- A. Listed in UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."
- B. Pressure Rating for Residential Sprinklers: 175-psig maximum.
- C. Pressure Rating for Automatic Sprinklers: 175-psig minimum.
- D. Pressure Rating for High-Pressure Automatic Sprinklers: 250-psig minimum.
- E. Automatic Sprinklers with Heat-Responsive Element:
 1. Nonresidential Applications: UL 199.
 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.
- F. Sprinkler Finishes: Chrome plated and painted.
- G. 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: Aluminum, white finish, one piece, flat.
- H. Sprinkler Guards:

1. Standard: UL 199.
2. Type: Wire cage with fastening device for attaching to sprinkler.

2.08 ALARM DEVICES

- A. Alarm-device types shall match piping and equipment connections.
- B. Electrically Operated Alarm Bell:
 1. Standard: UL 464.
 2. Type: Vibrating, metal alarm bell.
 3. Size: 6-inch minimum diameter.
 4. Finish: Red-enamel factory finish, suitable for outdoor use.
 5. 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.
- C. Pressure Switches:
 1. Standard: UL 346.
 2. Type: Electrically supervised water-flow switch with retard feature.
 3. Components: Single-pole, double-throw switch with normally closed contacts.
 4. Design Operation: Rising pressure signals water flow.
- D. Valve Supervisory Switches:
 1. Standard: UL 346.
 2. Type: Electrically supervised.
 3. Components: Single-pole, double-throw switch with normally closed contacts.
 4. Design: Signals that controlled valve is in other than fully open position.
 5. 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

2.09 MANUAL CONTROL STATIONS

- A. Listed in UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide" for hydraulic operation, with union, NPS 1/2 pipe nipple, and bronze ball valve.
- B. Include metal enclosure labeled "MANUAL CONTROL STATION" with operating instructions and cover held closed by breakable strut to prevent accidental opening.

2.10 CONTROL PANELS

- A. Description: Single-area, two-area, or single-area cross-zoned type control panel as indicated, including NEMA ICS 6, Type 1 enclosure, detector, alarm, and solenoid-valve circuitry for operation of deluge valves.
 - 1. Listed in UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide" when used with thermal detectors and Class A detector circuit wiring.
 - 2. Electrical characteristics are 120-V ac, 60 Hz, with 24-V dc rechargeable batteries.
 - 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
- B. Manual Control Stations: Electric operation, metal enclosure, labeled "MANUAL CONTROL STATION," with operating instructions and cover held closed by breakable strut to prevent accidental opening.
- C. Manual Control Stations: Hydraulic operation, with union, NPS 1/2 pipe nipple, and bronze ball valve. Include metal enclosure labeled "MANUAL CONTROL STATION," with operating instructions and cover held closed by breakable strut to prevent accidental opening.
- D. Panels Components:
 - 1. Power supply.
 - 2. Battery charger.
 - 3. Standby batteries.
 - 4. Field-wiring terminal strip.
 - 5. Electrically supervised solenoid valves and polarized fire-alarm bell.
 - 6. Lamp test facility.
 - 7. Single-pole, double-throw auxiliary alarm contacts.
 - 8. Rectifier.

2.11 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.
- D. Label: Include "WATER" or "AIR/WATER" label on dial face.

- E. Air System Piping Gage: Include retard feature and “AIR” or “AIR/WATER” label on dial face.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Perform fire-hydrant flow test according to NFPA 13 and NFPA 291. Use results for system hydraulic calculations required in “Quality Assurance” Article.
- B. Report test results promptly and in writing.

3.02 SERVICE-ENTRANCE PIPING

- A. Install shutoff valve, check valve, pressure gage, and drain at connection to water service.

3.03 WATER-SUPPLY CONNECTIONS

- A. Connect sprinkler piping to building's interior water-distribution piping. Comply with requirements for interior piping in Section 221116 “Domestic Water Piping.”
- B. Install shutoff valve, check valve, pressure gage, and drain at connection to water supply.

3.04 PIPING INSTALLATION

- A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated on approved working plans.
 - 1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect-Engineer before deviating from approved working plans.
 - 2. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.
- B. Piping Standard: Comply with NFPA 13 requirements for installation of sprinkler piping.
- C. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
- D. Install unions adjacent to each valve in pipes NPS 2 and smaller.
- E. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.
- F. Install “Inspector's Test Connections” in sprinkler system piping, complete with shutoff valve, and sized and located according to NFPA 13.
- G. Install sprinkler piping with drains for complete system drainage.
- H. Install sprinkler control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.

- I. Install automatic (ball drip) drain valves to drain piping between fire department connections and check valves. Drain to floor drain or to outside building.
- J. Connect air compressor to the following piping and wiring:
 - 1. Pressure gages and controls.
 - 2. Electrical power system.
 - 3. Fire-alarm devices, including low-pressure alarm.
- K. Install alarm devices in piping systems.
- L. Install pressure gages on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gages with connection not less than NPS 1/4 and with soft-metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they are not subject to freezing.
- M. Drain pre-action sprinkler piping.
- N. Pressurize and check pre-action sprinkler system piping and air-pressure maintenance devices
- O. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 21 05 17 "Sleeves and Sleeve Seals for Fire-Suppression Piping."
- P. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 21 05 17 "Sleeves and Sleeve Seals for Fire-Suppression Piping."
- Q. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 21 05 18 "Escutcheons for Fire-Suppression Piping."

3.05 JOINT CONSTRUCTION

- A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.
- B. Install unions adjacent to each valve in pipes NPS 2 and smaller.
- C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.
- D. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- E. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- F. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.

- G. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- H. Twist-Locked Joints: Insert plain end of steel pipe into plain-end-pipe fitting. Rotate retainer lugs one-quarter turn or tighten retainer pin.
- I. Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe joints.
- J. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Braze Joints" Chapter.
- K. Copper-Tubing Grooved Joints: Roll rounded-edge groove in end of tube according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join copper tube and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.
- L. Copper-Tubing, Pressure-Sealed Joints: Join copper tube and copper pressure-seal fittings with tools recommended by fitting manufacturer.
- M. Extruded-Tee Connections: Form tee in copper tube according to ASTM F 2104. Use tool designed for copper tube; drill pilot hole, form collar for outlet, dimple tube to form seating stop, and braze branch tube into collar.
- N. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.06 VALVE AND SPECIALTIES INSTALLATION

- A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 13 and authorities having jurisdiction.
- B. Install listed fire-protection shutoff valves supervised open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.
- C. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.
- D. Specialty Valves:
 - 1. Install valves in vertical position for proper direction of flow, in main supply to system.
 - 2. Install deluge valves with trim sets for air supply, drain, priming level, alarm connections, ball drip valves, pressure gages, priming chamber attachment, and fill-line attachment.

- a. Install air compressor and compressed-air-supply piping.
- b. Install air-pressure maintenance device with shutoff valves to permit servicing without shutting down sprinkler system; bypass valve for quick system filling; pressure regulator or switch to maintain system pressure; strainer; pressure ratings with 14- to 60-psig Insert value adjustable range; and 175-psig maximum inlet pressure.
- c. Install compressed-air-supply piping from building's compressed-air piping system.

3.07 SPRINKLER INSTALLATION

- A. Install sprinklers in suspended ceilings in center of acoustical ceiling panels.
- B. Install dry-type sprinklers with water supply from heated space. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing.
- C. Install sprinklers into flexible, sprinkler hose fittings, and install hose into bracket on ceiling grid.

3.08 IDENTIFICATION

- A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.
- B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

3.09 FIELD QUALITY CONTROL

- 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. Start and run air compressors.
 6. Coordinate with fire-alarm tests. Operate as required.
 7. Coordinate with fire-pump tests. Operate as required.
 8. 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.
- C. Prepare test and inspection reports.

3.10 CLEANING

- A. Clean dirt and debris from sprinklers.
- B. Only sprinklers with their original factory finish are acceptable. Remove and replace any sprinklers that are painted or have any other finish than their original factory finish.

3.11 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain specialty valves.

3.12 PIPING SCHEDULE

- A. Piping between Fire Department Connections and Check Valves: Galvanized, standard-weight steel pipe with grooved ends, grooved-end fittings, grooved-end-pipe couplings, and grooved joints.
- B. Sprinkler specialty fittings may be used, downstream of control valves, instead of specified fittings.
- C. Copper-tube, extruded-tee connections may be used for tee branches in copper tubing instead of specified copper fittings. Branch-connection joints must be brazed.
- D. Standard-pressure, pre-action sprinkler system, NPS 2 and smaller shall be one of the following:
 - 1. Schedule 40, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.
 - 2. Schedule 40, galvanized-steel pipe with plain ends; plain-end-pipe fittings; and twist-locked joints.
 - 3. Schedule 40, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
- E. Standard-pressure, pre-action sprinkler system, NPS 2-1/2 to NPS 4, shall be one of the following:
 - 1. Schedule 40, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.
 - 2. Schedule 40, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

3.13 SPRINKLER SCHEDULE

- A. Use sprinkler types in subparagraphs below for the following applications:
 - 1. Rooms with Suspended Ceilings pendent sprinklers as indicated.
- B. Provide sprinkler types in subparagraphs below with finishes indicated.
 - 1. Recessed Sprinklers: Bright chrome, with bright chrome escutcheon.

END OF SECTION 21 13 16

SECTION 21 22 00
CLEAN-AGENT FIRE-EXTINGUISHING SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other related Specification sections, apply to this section.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00.
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) requirements.

1.03 SUMMARY

- A. Section Includes:
 - 1. Piping and piping specialties.
 - 2. Extinguishing-agent containers.
 - 3. Extinguishing agent.
 - 4. Detection and alarm devices.
 - 5. Control and alarm panels.
 - 6. Accessories.
 - 7. Connection devices for and wiring between system components.
 - 8. Connection devices for power and integration into building's fire-alarm system.

1.04 DEFINITIONS

- A. ATS: Acceptance Testing Specifications.
- B. EPO: Emergency Power Off.

1.05 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For clean-agent fire-extinguishing system signed and sealed by a qualified professional engineer registered in the State of Florida.
 - 1. Include plans, elevations, sections, details, and attachments to other work.
 - 2. Include all design calculations.

3. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 4. Wiring Diagrams: For power, signal, and control wiring.
 5. Coordinate all requirements with the fire alarm system contractor and installer. Do not duplicate controls and systems. Obtain copy of fire alarm shop drawings and submit clean agent system shop drawings together for review.
- C. Delegated-Design Submittal: For clean-agent fire-extinguishing system signed and sealed by the qualified professional engineer.
1. Indicate compliance with performance requirements and design criteria, including analysis data.
 2. Include design calculations for weight, volume, and concentration of extinguishing agent required for each hazard area.
 3. Indicate the Following on Reflected Ceiling Plans:
 - a. Ceiling penetrations and ceiling-mounted items.
 - b. Extinguishing-agent containers if mounted above floor, piping and discharge nozzles, detectors, and accessories.
 - c. Method of attaching hangers to building structure.
 - d. Other ceiling-mounted items including light fixtures, diffusers, grilles, speakers, sprinklers, and access panels.
 4. Indicate the Following on Occupied Work Area Plans:
 - a. Controls and alarms.
 - b. Extinguishing-agent containers, piping and discharge nozzles if mounted in space, detectors, and accessories.
 - c. Equipment and furnishings.
 5. Indicate the Following on Access Floor Space Plans:
 - a. Extinguishing-agent containers, piping and discharge nozzles, detectors, and accessories.
 - b. Method of supporting piping.
 6. Indicate the Following on Ceiling Plans:
 - a. Extinguishing-agent containers, piping and discharge nozzles, detectors, and accessories.
 - b. Method of supporting piping.

- c. Other equipment located in the ceiling space that is being protected including sprinkler piping, HVAC equipment, raceways, or conduit.
7. Coordinate all requirements with the fire alarm system contractor and installer. Do not duplicate controls and systems. Obtain copy of fire alarm shop drawings and submit clean agent system shop drawings together for review.

1.06 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Sprinkler systems, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:
 1. Domestic water piping.
 2. Items Penetrating Finished Ceiling Include the Following:
 - a. Lighting fixtures.
 - b. Air outlets and inlets.
 - c. Life Safety fixtures.
 - d. Speakers.
 3. HVAC equipment.
 4. Data equipment.
- B. Permit Approved Drawings: Working plans, prepared according to NFPA 2001 and NFPA 75, that have been approved by authorities having jurisdiction. Include design calculations.
- C. Field quality-control reports.

1.07 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For special agent system to include in emergency, operation, and maintenance manuals.

1.08 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. Deliver extra materials to Owner.
 1. Detection Devices: Not less than 20 percent of amount of each type installed.
 2. Container Valves: Not less than 10 percent of amount of each size and type installed.
 3. Nozzles: Not less than 20 percent of amount of each type installed.
 4. Extinguishing Agent: Not less than 100 percent of amount installed in largest hazard area. Include pressure-rated containers with valves.

1.09 QUALITY ASSURANCE

- A. 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.
- B. FM Global Compliance: Provide components that are FM Approved and that are listed in FM Global's "Approval Guide."
- C. UL Compliance: Provide equipment listed in UL's "Fire Protection Equipment Directory."

1.10 WARRANTY

- A. Warranty: Repair or replace components that fail in materials or workmanship. Manufacturer's warranty shall be in the name of the Owner.
 - 1. Warranty Period: One year minimum from date of Substantial Completion, or longer if standard manufacturer's warranty is longer.

PART 2 - PRODUCTS

2.01 CLEAN-AGENT SYSTEMS

- A. Description: Clean-agent fire-extinguishing system shall be an engineered system for total flooding of the hazard area including the room cavity below the ceiling and below the raised floor. System shall include one zone for below the ceiling and beneath the raised floor, where required. If smoke is detected below the ceiling or below floor, extinguishing agent shall be discharged in zones above and below the ceiling and below the floor. Each room will be shall be treated as one zone.
- B. Delegated Design: Design clean-agent fire-extinguishing system and obtain approval from authorities having jurisdiction. Design system for Class A, B, and C fires as appropriate for areas being protected, and include safety factor. Use clean agent indicated and in concentration suitable for normally occupied areas.
- C. Performance Requirements: Discharge HFC 227ea or equivalent within 10 seconds and 7.1 percent concentration by volume at 70°F for 10-minute holding time in hazard areas.
 - 1. HFC 227ea or equivalent concentration in hazard areas greater than 9.0 percent immediately after discharge or less than 5.8 percent throughout holding time will not be accepted without written authorization from Owner and authorities having jurisdiction.
 - 2. System Capabilities: Minimum 620-psig calculated working pressure and 360-psig initial charging pressure.
- D. Verified Detection: Devices located in single zone. Sound alarm on activating single-detection device, and discharge extinguishing agent on actuating second-detection device.
- E. System Operating Sequence:
 - 1. Actuating First Detector: Visual indication on annunciator panel. Energize audible and visual alarms (slow pulse), shut down air-conditioning, ventilating systems and close HVAC dampers serving protected area, close doors in protected area, and send signal to fire-alarm system.

2. Actuating Second Detector: Visual indication on annunciator panel. Energize audible and visual alarms (fast pulse), shut down power to protected equipment, start time delay for extinguishing-agent discharge for 30 seconds, and discharge extinguishing agent.
 3. Expiration of the adjustable time delay or when manual pull station is activated shall, transfer discharge relay contacts, energize release circuit with discharges the clean agent gas in the protected space. Extinguishing-agent discharge will operate audible alarms and strobe lights inside and outside the protected area. Initiate building fire alarm evacuation signals.
- F. Manual stations shall immediately discharge extinguishing agent when activate and initiate the building fire alarm evacuation signals.
 - G. Operating abort switches will delay extinguishing-agent discharge while being activated, and switches must be reset to prevent agent discharge. Release of hand pressure on the switch will cause agent discharge if the time delay has expired.
 - H. EPO: Will terminate power to protected equipment immediately on actuation.
 - I. Low-Agent Pressure Switch: Initiate trouble alarm if sensing less than set pressure.
 - J. Power Transfer Switch: Transfer from normal to stand-by power source.
 - K. Seismic Performance: Fire-suppression piping and containers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 1. The term “withstand” means “the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event.”

2.02 PIPING MATERIALS

- A. See “HFC 227ea or equivalent Agent Piping Applications”, Article for applications of pipe, tube, fitting, and joining materials.
- B. Piping, Valves, and Discharge Nozzles: Comply with types and standards listed in NFPA 2001, Section “Distribution,” for charging pressure of system.

2.03 PIPE AND FITTINGS

- A. Steel Pipe: ASTM A 53/A 53M, Type S, Grade B or ASTM A 106/A 106M, Grade A; Schedule 40, Schedule 80, and Schedule 160 or seamless steel pipe.
 1. Threaded Fittings:
 - a. Malleable-Iron Fittings: ASME B16.3, Class 300.
 - b. Flanges and Flanged Fittings: ASME B16.5, Class 300 unless Class 600 is indicated.
 - c. Fittings Working Pressure: 620 psig minimum.
 - d. Flanged Joints: Class 300 minimum.

2. Forged-Steel Welding Fittings: ASME B16.11, Class 3000, socket pattern.
 3. Steel, Grooved-End Fittings: FM Approved and NRTL listed, ASTM A 47/A 47M malleable iron or ASTM A 536 ductile iron, with dimensions matching steel pipe and ends factory grooved according to AWWA C606.
- B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
- C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel.
- D. 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.
- E. Steel, Keyed Couplings: UL 213, AWWA C606, approved or listed for clean-agent service, and matching steel-pipe dimensions. Include ASTM A 536, ductile-iron housing, rubber gasket, and steel bolts and nuts.

2.04 VALVES

- A. General Valve Requirements:
1. UL listed or FM Approved for use in fire-protection systems.
 2. Compatible with type of clean agent used.
- B. Container Valves: With rupture disc or solenoid and manual-release lever, capable of immediate and total agent discharge and suitable for intended flow capacity.
- C. Valves in Sections of Closed Piping and Manifolds: Fabricate to prevent entrapment of liquid, or install valve and separate pressure relief device.
- D. Valves in Manifolds: Check valve; installed to prevent loss of extinguishing agent when container is removed from manifold.

2.05 EXTINGUISHING-AGENT CONTAINERS

- A. Description: Steel tanks complying with ASME Boiler and Pressure Vessel Code: Section VIII, for unfired pressure vessels. Include minimum working-pressure rating that matches system charging pressure, valve, pressure switch, and pressure gage.
1. Finish: Red, enamel or epoxy paint.
 2. Manifold: Fabricate with valves, pressure switches, and connections for multiple storage containers, as indicated.
 3. Manifold: Fabricate with valves, pressure switches, selector switch, and connections for main- and reserve-supply banks of multiple storage containers.

4. Storage-Tank Brackets: Factory- or field-fabricated retaining brackets consisting of steel straps and channels; suitable for container support, maintenance, and tank refilling or replacement.

2.06 FIRE-EXTINGUISHING CLEAN AGENT

- A. HFC 227ea Clean Agent: Heptafluoropropane.
- B. FE-25.
- C. Approved equivalent.

2.07 DISCHARGE NOZZLES

- A. Equipment manufacturer's standard one-piece brass or aluminum alloy of type, size, discharge pattern, and capacity required for application.

2.08 MANIFOLD AND ORIFICE UNIONS

- A. Description: NRTL-listed device with minimum 2175-psig pressure rating, to control flow and reduce pressure of IG-541 gas in piping.
 1. NPS 2 and Smaller: Piping assembly with orifice, sized for system design requirements.
 2. NPS 2-1/2 and Larger: Piping assembly with nipple, sized for system design requirements.

2.09 CONTROL PANELS

- A. Description: FM Approved or NRTL listed, including equipment and features required for testing, supervising, and operating fire-extinguishing system.
- B. Power Requirements: 120/240-V ac; with electrical contacts for connection to system components and fire-alarm system, and transformer or rectifier as needed to produce power at voltage required for accessories and alarm devices.
- C. Enclosure: NEMA ICS 6, Type 1, enameled-steel cabinet.
 1. Mounting: Recessed flush with surface.
- D. Supervised Circuits: Separate circuits for each independent hazard area.
 1. Detection circuits using addressable devices assigned to the required number of zones.
 2. Manual pull-station circuit.
 3. Alarm circuit.
 4. Release circuit.
 5. Abort circuit.
 6. EPO circuit.

- E. Control-Panel Features:
 - 1. Electrical contacts for shutting down fans, activating dampers, and operating system electrical devices.
 - 2. Automatic switchover to standby power at loss of primary power.
 - 3. Storage container, low-pressure indicator.
 - 4. Service disconnect to interrupt system operation for maintenance with visual status indication on the annunciator panel.
- F. Annunciator Panel: Graphic type showing protected, hazard-area plans, as well as locations of detectors and abort, EPO, and manual stations. Include lamps to indicate device-initiating alarm, electrical contacts for connection to control panel, and stainless-steel or aluminum enclosure.
- G. Standby Power: Sealed lead calcium batteries with capacity to operate system for 24 hours and alarm for minimum of 15 minutes. Include automatic battery charger that has a varying charging rate between trickle and high depending on battery voltage, and that is capable of maintaining batteries fully charged. Include manual voltage control, dc voltmeter, dc ammeter, electrical contacts for connection to control panel, automatic transfer switch, and suitable enclosure.

2.10 DETECTION DEVICES

- A. General Requirements for Detection Devices:
 - 1. Comply with NFPA 2001, NFPA 72, and UL 268.
 - 2. 24-V dc, nominal.
 - 3. Provide all required smoke detection devices, and associated initiation and monitoring wiring, as part of the clean agent systems. Including detectors under the floor. These are not “building” fire alarm smoke detectors.
- B. Ionization Detectors: Dual-chamber type, having sampling and referencing chambers, with smoke-sensing element.
- C. Photoelectric Detectors: LED light source and silicon photodiode receiving element.
- D. Signals to the Central Fire Alarm Control Panel: Any type of local system trouble is reported to the central fire alarm control panel as a composite “trouble” signal. Alarms on each system zone are individually reported to the central fire alarm control panel as separately identified zones.

2.11 MANUAL STATIONS

- A. General Description: Surface FM Approved or NRTL listed, with clear plastic hinged cover, 120-V ac or low voltage compatible with controls. Include contacts for connection to control panel.
- B. Manual Release: “MANUAL RELEASE” caption, and red finish. Unit can manually discharge extinguishing agent with operating device that remains engaged until unlocked.

- C. Abort Switch: “ABORT” caption, momentary contact, with green finish.
- D. EPO Switch: “EPO” caption, with yellow finish.

2.12 SWITCHES

- A. Description: FM Approved or NRTL listed, where available, 120-V ac or low voltage compatible with controls. Include contacts for connection to control panel.
 - 1. Low-Agent Pressure Switches: Pneumatic operation.
 - 2. Power Transfer Switches: Key-operation selector, for transfer of release circuit signal from main supply to reserve supply.
 - 3. Door Closers: Magnetic retaining and release device or electrical interlock to cause the door operator to drive the door closed.

2.13 ALARM DEVICES

- A. Description: Listed and labeled by an NRTL or FM Approved, low voltage, and surface mounting. Comply with requirements in Section 28 31 11 “Digital, Addressable Fire-Alarm System” or Section 28 31 12 “Zoned (DC Loop) Fire-Alarm System” for alarm and monitoring devices.
- B. Bells: Minimum 6-inch diameter.
- C. Horns: 90 to 94 dBA.
- D. Strobe Lights: Translucent lens, with “FIRE” or similar caption.

2.14 SIGNAGE

- A. Instructional signs shall be installed to provide a system in which the function of each device is easy to understand.
- B. At each horn/strobe within the protected space the following sign shall be provided:

WARNING
 When Alarm Sounds
 Vacate at Once
 Extinguishing Agent
 Being Released

- C. At each strobe outside the protected space the following sign shall be provided:

CAUTION
 When Light Is Flashing
 Agent Has Discharged

- D. At each door entering the protected space the following sign shall be provided:

KEEP DOOR CLOSED
 Area Protected
 By Clean Agent Fire Suppression System

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with hazard-area leakage requirements, installation tolerances, and other conditions affecting work performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 HFC 227ea or equivalent agent PIPING APPLICATIONS

- A. Flanged pipe and fittings and flanged joints may be used to connect to specialties and accessories and where required for maintenance.
- B. NPS 2 and Smaller: Schedule 40, steel pipe; malleable-iron threaded fittings; and threaded joints.
- C. NPS 2-1/2 and Larger: Schedule 40, steel pipe; steel, grooved-end fittings; steel, keyed couplings; and grooved joints.

3.03 CLEAN-AGENT PIPING INSTALLATION

- A. Install clean-agent extinguishing piping and other components level and plumb, according to manufacturers' written instructions.
- B. Grooved Piping Joints: Groove pipe ends according to AWWA C606 dimensions. Assemble grooved-end steel pipe and steel, grooved-end fittings with steel, keyed couplings and lubricant according to manufacturer's written instructions.
- C. Install extinguishing-agent containers anchored to substrate.
- D. Install pipe and fittings, valves, and discharge nozzles according to requirements listed in NFPA 2001, Section "Distribution."
 - 1. Install valves designed to prevent entrapment of liquid, or install pressure relief devices in valved sections of piping systems.
 - 2. Support piping using supports and methods according to NFPA 13.
 - 3. Install seismic restraints for extinguishing-agent containers and piping systems.
 - 4. Install control panels, detection system components, alarms, and accessories, complying with requirements of NFPA 2001, Section "Detection, Actuation, and Control Systems," as required for supervised system application.

3.04 CONNECTIONS

- A. Where installing piping adjacent to equipment, allow space for service and maintenance.
- B. Connect electrical devices to control panel and to building's fire-alarm system. Electrical power, wiring, and devices are specified in Section 28 31 11 "Digital, Addressable Fire-Alarm System".

3.05 IDENTIFICATION

- A. Identify system components and equipment. Comply with requirements for identification specified in Section 260553 “Identification for Electrical Systems.”
- B. Identify piping, extinguishing-agent containers, other equipment, and panels according to NFPA 2001.
- C. Install signs at entry doors for protected areas to warn occupants that they are entering a room protected with a clean-agent fire-extinguishing system.
- D. Install signs at entry doors to advise persons outside the room the meaning of the horn(s), bell(s), and strobe light(s) outside the protected space.

3.06 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- C. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- D. Tests and Inspections:
 - 1. After installing clean-agent extinguishing piping system and after electrical circuitry has been energized, test for compliance with requirements.
 - 2. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Sections “Inspection and Test Procedures” and “System Function Tests.” Certify compliance with test parameters.
 - 3. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 4. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation. Remove malfunctioning units, replace with new units, and retest.
 - 5. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- E. Units will be considered defective if they do not pass tests and inspections.
- F. Prepare test and inspection reports.

3.07 CLEANING

- A. Each pipe section shall be cleaned internally after preparation and before assembly by means of swabbing, using a suitable nonflammable cleaner. Pipe network shall be free of particulate matter and oil residue before installing nozzles or discharge devices.

3.08 SYSTEM FILLING

A. Preparation:

1. Verify that piping system installation is completed and cleaned.
2. Check for complete enclosure integrity.
3. Check operation of ventilation and exhaust systems.

B. Filling Procedures:

1. Fill extinguishing-agent containers with extinguishing agent, and pressurize to indicated charging pressure.
2. Install filled extinguishing-agent containers.
3. Energize circuits.
4. Adjust operating controls.

3.09 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain clean-agent fire-extinguishing systems.

END OF SECTION 21 22 00

SECTION 22 00 00
PLUMBING REQUIREMENTS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.
- B. Division 22 Basic Mechanical Materials and Methods sections apply to work of this section.
- C. Work herein shall conform to all applicable laws, ordinances, and to regulations of the local utility companies. The general conditions and all requirements of the contract documents shall apply to all work of this section. Work shall be in accordance with the requirements of:
 - 1. Florida Building Code (FBC) 8th Edition (2023): This code includes the 2023 FBC Building, Mechanical, Plumbing, Energy Conservation, Fuel Gas, Accessibility, and Test Protocols volumes. Further, see "Referenced Standards" in the FBC Building Chapter 35; FBC Mechanical Chapter 15; FBC Plumbing Chapter 15; FBC Energy Conservation Chapter 6; and FBC Fuel Gas Chapter 8) (Effective December 31, 2023).
 - 2. 8th Edition of the Florida Fire Prevention Code (FFPC): This code also includes the Florida versions of NFPA 1 and NFPA 101. (Effective December 31, 2023).
 - 3. 2020 National Electric Code.
- D. Cooperate with all other trades and install work as fast as the progress of the job will permit.
- E. Use only mechanics skilled in the work they are to perform and have a competent representative on the job when any work is being done.
- F. No work shall be done unless the Superintendent of the Contractor is on the job site. Work shall be properly protected, all rubbish removed promptly, and exposed work shall be carefully cleaned prior to final acceptance.
- G. The term "provide" shall include labor, materials, and equipment necessary to furnish and install, complete and operable, the item or system indicated.
- H. In decisions arising from discrepancies, interpretation of Drawings and Specifications, substitutes, and other pertinent matters, the decision of the Owner's representative's approval shall be final.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00.

1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) requirements.

1.03 SPECIFICATIONS AND DRAWINGS

- A. Plans show location of fixtures and equipment and are intended to depict the general intent of the work in scope, layout and quality of workmanship. They are not intended to show in minute detail every or all accessories intended for the purpose of executing the work, but it is understood that such details are a part of this work.
- B. Where Drawings and Specifications conflict, it shall be the responsibility of this Contractor to bring such conflict to the attention of the Architect/Engineer for clarification. Refer to Supplementary Conditions. In general, the Architectural Drawings shall take precedence over the Mechanical Drawings with reference to building construction. All changes from the Drawings necessary to make the work conform with the building as constructed and to fit the work of other trades or to conform to the rules of authorities having jurisdiction, shall be made by the Contractor at his own expense.
- C. Keep a record of the locations of concealed work and of any field changes in Contract Drawings and Specifications for each trade and, upon completion of the job. Refer to Specification Section 017000, “Closeout” for requirements.

1.04 PERMITS, FEES AND INSPECTIONS:

- A. The Contractor shall give all necessary notices, obtain all permits and pay all government fees in accordance with the Supplementary Conditions, sales taxes and other costs, including utility connections or extensions, in connection with this work; file all permit applications required by all governmental departments having jurisdiction.
- B. Obtain all required certificates of inspection for work and deliver them to the Owner before requesting acceptance and final payment for the work.
- C. The Contractor shall include in the work, without extra cost to the Owner, any labor, materials, services, apparatus and drawings required to comply with all applicable laws, ordinances, rules and regulations.
- D. The Contractor shall inform the Owner of any work or materials which conflict with any of the applicable codes, standards, laws and regulations before submitting his bid.

1.05 GENERAL

- A. Materials or products specified herein and/or indicated on drawings by trade name, manufacturer's name and/or catalog number shall be provided as specified. Substitutions will not be permitted except as described herein and in the Supplementary and General Conditions.
- B. Since manufacturers reserve the right to change their products at any time, contractors shall verify all dimensions, performance data, etc. for each piece of equipment submitted to assure compliance with the intent of the drawings and specifications.
- C. All materials shall be new and of quality as specified, and when required, be clearly labeled and/or stamped as manufactured in the United States.

- D. Where an accepted substitution or deviation requires different quantity or arrangement of foundations, supports, ductwork, piping, wiring, conduit, and any other equipment or accessories normal to this equipment, contractor shall furnish said changes and additions and pay all costs for all changes and additions to his work and the work of others affected by this substitution or deviation.
- E. Deviations mean the use of any listed approved manufacturer other than those on which the drawings are based.

1.06 SHOP AND ERECTION DRAWINGS AND SAMPLES

- A. The Architect/Engineer's approval shall be obtained for all equipment and material before delivery to the job site. Delivery, storage or installation of equipment or material which has not had prior approval will not be permitted at the job site. Submittals shall be made for all equipment and systems as indicated in the respective specification section.
- B. All submittals shall include adequate descriptive literature, catalog cuts, shop drawings and other data necessary for the Architect/Engineer to ascertain that the proposed equipment and materials comply with specification and drawing requirements. Catalog cuts submitted for approval shall be legible and clearly identify equipment being submitted.
- C. Shop and erection drawing submittals shall conform to the requirements of the General Conditions and Division 00 specifications except as modified herein.
- D. Submit required and/or requested shop and erection drawings, for review by Architect/Engineer before ordering or installing any equipment or material. Equipment or material ordered or installed before Architect/Engineer review may not be accepted and may have to be removed from the project if deemed unacceptable.
- E. Shop drawings shall consist of manufacturer's scale drawings, cuts or catalogs, including descriptive literature which shall clearly indicate the construction, material, physical dimensions, wiring diagrams and complete operating data clearly marked for each item. Data of general nature will not be accepted.
- F. Shop drawings on paper larger than 11"x17" shall be submitted in the form of one set of reproducibles (vellum) and one set of blueprints. The blueprints will be retained by the engineer and the reproducibles will be returned to the contractor.
 - 1. Coordination drawings shall show major elements, components, and systems of mechanical equipment and materials in relationship with other building components. Prepare drawings to an accurate scale of 1/4"=1'-0" or larger. Indicate the locations of all equipment and materials, including clearances for installing, servicing and maintaining equipment, valve stem movement, and similar requirements. Indicate movement and positioning of large equipment into the building during construction.
- G. Submittals for individual systems and equipment assemblies which consist of more than one item or component shall be made for the system or assembly as a whole. Partial submittals will not be considered for approval. Submittals shall be submitted for all applicable products and materials specified in each individual section of these specifications.
- H. Make submittals for the equipment and materials in accordance with the following:

1. Mark the submittals, "SUBMITTED UNDER SECTION_____".
2. Submittals shall be marked to show specification reference including the section and paragraph numbers.
3. The submittals shall include the following:
 - a. Information that confirms compliance with contract requirements. Include the manufacturer's name, model or catalog numbers, catalog information, technical data sheets, shop drawings, pictures, nameplate data and test reports as required. Provide any additional information specifically requested in the individual specification section or on the drawings.
 - b. Parts list which shall include those replacement parts recommended by the equipment manufacturer, quantity of parts, current price and availability of each part.
4. Electronic PDF submittal files shall be named utilizing the specification number followed by a sequential number for the submittal made under the given specification number followed by "r#" if it is a resubmittal, and then followed by a brief description of the submitted item.
 - a. The description shall indicate the actual item submitted, shall not be general in nature, and does not have to be that of the specification section heading.
 - b. Using the example, "22 05 19-4r2 Differential Pressure Gauge"; 22 05 19 – Meters and Gauges is the relevant specification, the "4" shows it was the fourth submittal for specification section 22 05 19 02, "r2" shows it was the second resubmittal, and the description indicates what item is submitted.
 - c. Each specification item shall be submitted in a separate PDF file. PDF files with multiple specification items will be returned without review.
 - d. Each file shall have sufficient space allowance for the Architects and Engineer's review stamp(s).
 - e. Each file shall have the Constructions Managers review stamp(s) and indicate information required by specification 22 00 00.1.5.K.
- I. Shop drawings on paper 11"X17" or smaller in size shall be submitted in a tabbed and indexed three ring binder. The binder shall not exceed 11-5/8" height. Partial submittals are unacceptable. The index shall indicate the related specification section number.
- J. A fee will be charged for Engineering review plans that have been rejected two or more times due to non-compliance or incompleteness. The fee will be determined by the Architect/Engineer and the CM will backcharge the responsible subcontractor and will reimburse the Owner by change order for the additional fees.
- K. The Construction Manager will certify that all Division 22 shop drawings are in conformance with the plans and specifications. Deviations from the plans and specifications shall be noted, and the specific area of the deviation clouded and in contrasting color (green) with a complete explanation for the reasons for the deviation. Any redesign of the system shall be Certified by a Professional Engineer currently registered in the State of Florida, and will be accompanied by the fees as described in "J" above.

- L. Carefully examine all shop drawings and mark-up as necessary before submitting to the Architect/Engineer for review. The consultant will only consider shop drawings bearing the contractor's stamp of approval.
- M. The engineer's review shall not relieve the contractor from the responsibility for deviations from drawings and specifications. The engineer's review shall be construed to apply only to general arrangement and shall not relieve the contractor from the responsibility for the correctness of details and dimensions and provision of the correct equipment.
- N. The contractor shall retain copies of all reviewed shop drawings on the job site for reference.
- O. In addition to the requirement of SUBMITTALS, the Owner reserves the right to request the manufacturer to arrange for the Owner's representative(s) to see typical active systems in operation, when there has been no prior experience with the manufacturer or the type of equipment being submitted.

1.07 EXPERIENCE

- A. The Contractor performing this work shall be a licensed, reputable firm, regularly performing the type of work incorporated in this project and who also maintains, as part of the firm, a service department with qualified personnel who regularly perform this type of work. The Contractor shall, upon request, show evidence of at least two jobs of similar character and size installed within the preceding two years.

1.08 COORDINATION WITH OTHER TRADES

- A. Contractor shall coordinate his work with other trades to avoid interferences and delays. He shall assist in working out space requirements to make a satisfactory installation.
- B. If the Contractor installs his work before coordinating with other trades, or so as to cause any interference with the work of other trades, he shall make the necessary changes in his work to correct the condition without extra charge.
- C. The Contractor shall furnish to other trades, as required, all necessary templates, patterns, setting plans, and shop details for the proper installation of work and for the purpose of coordinating adjacent work.

1.09 STORAGE OF MATERIALS

- A. All materials stored on site shall be properly protected from injury or deterioration. Materials shall not be stored in contact with ground or floor.
- B. Do not remove manufacturer's packing materials until ready to install. Materials showing signs of corrosion, improper handling or storage shall be replaced at no cost to the Owner.
- C. Provide continuous protection for all equipment already installed.

1.10 CUTTING, PATCHING, EXCAVATION, BACKFILL, AND LAYOUT

- A. Provide openings and excavation required for the installation of the work. Patch work and backfill as required. Finished work shall match the existing adjoining work.

- B. Verify all conditions affecting the work to be performed under this contract.
- C. Carefully verify measurements at the site, determine the exact location of chases and openings required. Provide sleeves, inserts, and hangers as required. No columns, beams, joists, building foundations or any other structural building component shall be cut, drilled or disturbed in any way. Conflicts shall immediately be brought to the attention of the Architect/Engineer.
- D. All excavation on sites containing existing buildings and existing services shall be done with hand shovel to avoid damage to existing services. Any damage incurred by the Contractor shall be repaired by the Contractor in a manner approved by the Architect/Engineer at no cost to the Owner and with no extension of time limitation.

1.11 REMOVAL OF RUBBISH

- A. Contractor shall keep premises free from accumulations of waste material or rubbish caused by his employees or work in accordance with Division 00 - Construction Procedures. At completion of work, he shall remove all his tools, scaffolding, surplus materials, and rubbish from building and site. He shall leave premises and his work in a clean orderly condition acceptable to the Architect/Engineer.

1.12 ELECTRICAL WORK FOR MECHANICAL SYSTEMS

- A. Factory installed starters, controllers, and control equipment mounted in manufactured mechanical equipment necessary for mechanical equipment operation shall be furnished under Division 22.
- B. Power wiring for motors and installation of starters shall be under Division 26 Electrical.
- C. Temperature, humidity, pressure and similar controls essential to the operation of mechanical systems, and wiring and conduit thereof, including interlock wiring, shall be under Division 22 of specifications, installed in accordance with requirements of Division 26.
- D. Motors shall be furnished under Division 22 of capacity required to operate equipment specified, but shall not be less than that specified.
- E. Furnish and install all low voltage (120V and under) temperature control wiring for equipment provided under this division.
- F. Provide conduit when required for control wiring.

1.13 MOTORS

- A. All motors shall be furnished and installed under Division 22 and shall be wired under Division 26 Electrical.
- B. All motors shall be built in accordance with the current applicable IEEE, ASA, and NEMA standards. All general purpose motors shall be open drip-proof machines for installation indoors and/or in protected locations. Totally enclosed fan cooled (TEFC) motors shall be used in all areas of exposure to weather or other environmental contamination. Motors shall be rated explosion proof when located in hazardous atmospheres. Type II weather protected motors may be used in lieu of TEFC motors on roof mounted fan units and similar equipment.

- C. Unless indicated otherwise, motors shall be NEMA Design B with a service factor of 1.15 with total temperature rise of 90 degrees C. (resistance measured) in 40 degrees C. ambient when powered from the system voltage feeding the motor. TEFC motors shall have a service factor of 1.00 with total temperature rise of 80 degrees C. in the above conditions. Motors located in areas exceeding 40 degrees C. ambient shall be factory rated for the ambient temperature of the motor environment. Single phase motors shall generally be NEMA Design N split phase induction motors with built-in thermal protectors. Single phase motors connected on loads requiring high starting torque shall be capacitor-start induction motors. Single phase motors of 1/10 HP or less may be shaded pole induction motors.
- D. If the Contractor proposes to furnish motors varying in horsepower and/or characteristics from those specified, he shall first inform the Architect/Engineer of the change and shall then coordinate the change and shall pay all additional charges in connection with the change.
- E. All motors supplied on this project three (3) HP and larger shall have a power factor not less than 85 percent under rated load conditions. Power factor of less than 85 percent shall be corrected to at least 90 percent under rated load conditions. Power factor corrective devices, installed to comply with this Code, shall be switched with the utilization equipment.
- F. All motors supplied on this project shall be energy efficient. All efficiency testing and labeling shall be performed in accordance with the NEMA Standard MG 1-12.54 and IEEE 112 Test Standard, Method B. Minimum efficiencies shall conform to the following listing:

Motor HP	Efficiency (%)
3/4	80.0
1	82.5
1-1/2	84.0
2	85.5
3	87.5
5	87.5
7-1/2	89.5
10	89.5
15	91.0
20	91.7

1.14 QUIET OPERATION AND VIBRATION

- A. All equipment provided under this section shall operate under all conditions of load free of objectionable sound and vibration. Sound and vibration conditions considered objectionable shall be corrected in an approved manner.
- B. Vibration and sound control shall be by means of approved vibration eliminators or sound attenuators in a manner as specified and as recommended by the manufacturer.

1.15 EQUIPMENT IDENTIFICATION

- A. Each unit shall be identified by its system number and other appropriate designation by stenciling in letters of approved size and wording. Equipment requiring identification shall include: supply and exhaust fans, air conditioning and heating machinery and apparatus, pumps, piping, control cabinets, and other equipment units as may be directed by the Architect/Engineer.

1.16 CLEANING AND ADJUSTMENTS

- A. Upon completion of the work, Contractor shall clean and lubricate fans, motors, and other running equipment and apparatus which he has installed and make certain such apparatus and mechanisms are in proper working order and ready to test.
- B. Scratched or damaged painting shall be touched up as necessary to return the painting to "new" condition and appearance.
- C. All piping and equipment shall be thoroughly blown out under pressure and cleared of all foreign matter, wasting air, gas or water through temporary connections as long as necessary to thoroughly clean system before system is placed in operation. Use every precaution to prevent pipe compound, scale, dirt, welding and other objectionable matter from getting into the piping system and equipment.
- D. During blow out period, baskets from strainers shall be removed, traps and control valves, etc., shall be by-passed.
- E. All cleaning shall be done prior to any sterilization, pressure testing, flow balancing or equipment adjustment procedures.
- F. During construction protect all piping and equipment from damage and dirt. Cap the open ends of all piping and equipment.

1.17 DEMOLITION

- A. Demolition shall be as shown on drawings or specified.
- B. Schedule all demolition work with Owner to cause minimum downtime of any building service or function. No extra cost to the contract will be allowed for overtime work unless specifically authorized in advance by representative of Owner in writing.
- C. During demolition and construction protect from damage all existing equipment and services that are to remain. Repair or replace any damage to existing facilities at no extra cost to the contract.
- D. Remove with care and deliver to a location designated by representative of the Owner all items designated to remain the property of the Owner.
- E. Drawings are diagrammatic and shown only major obstructions; coordinate with other trades for removal or relocation of pipes; conduits, hangers, etc. in path of work.
- F. No columns, beams, joists, building foundations or any other structural building component shall be cut, drilled or disturbed in any way. Conflicts shall immediately be brought to the attention of the Architect/Engineer. Contractor shall not proceed until

instructed in writing by the Architect/Engineer if conflicts between mechanical work and structural elements occur.

1.18 CONNECTIONS TO EXISTING WORK

- A. Plan installation of new work and connections to existing work to insure minimum interference with regular operation of existing facilities.
- B. Submit to the Owner for approval, a schedule of necessary temporary shut-downs of existing services. All shutdowns shall be made at such times as will not interfere with regular operating of existing facilities and only after written approval of the Owner.
- C. To insure continuous operation, make necessary temporary connections between new and existing work.
- D. Connect new work to existing work in neat and approved manner. Restore existing work disturbed to original condition.

1.19 WATERPROOFING

- A. Where any work pierces waterproofing including waterproof concrete, the method of installation shall be as approved by the Owner before the work is done.
- B. Provide all necessary sleeves, caulking and flashing required to make openings absolutely watertight. Waterproof flashing materials shall be compatible with base materials.

1.20 TESTS

- A. Contractor shall make all tests required to establish the adequacy, quality, safety, completed status and satisfactory operation of all systems to the satisfaction of the Architect/Engineer. Provide all instruments, labor and services necessary to conduct tests.

1.21 INSTRUCTIONS

- A. Fully instruct Owner's personnel in the care and operation of mechanical systems and furnish a letter to the Architect/Engineer advising the particular person who has received such instruction.

1.22 WARRANTY

- A. Equipment shall be started, tested, adjusted, and placed in satisfactory operating condition. Furnish a letter addressed to the Architect/Engineer advising that the completed systems have been installed in accordance with the Plans and Specifications and that they are in proper operating condition. The Owner shall receive a written warranty covering all defects in workmanship and material for a period of one year from date of final acceptance. Any defects appearing within this one year period shall be repaired without additional cost to the Owner.

1.23 ACCEPTANCE

- A. Before requesting final inspection:

1. Complete all work required. If any items are held in abeyance as incomplete for final inspection, list such items together with explanation for delay.
 2. Submit statement that equipment is properly installed, adjusted, fully lubricated and operation is satisfactory.
 3. Certify in writing to the Architect/Engineer that the Owner's representative has been instructed as to the care and operation of the system and that catalog service and maintenance information has been turned over to the Architect/Engineer.
 4. Submit copy of written guarantee.
 5. Submit copy of other data as may be outlined in these specifications.
- B. Copies of the above data shall be submitted to the Architect/Engineer prior to requesting final inspection.

1.24 FACILITY STARTUP BROCHURE

- A. At the completion of work, Contractor shall provide startup instruction in accordance with Division 00, "Closeout" and shall submit a bound brochure containing the following:
1. Shop Drawings
 2. Maintenance Manuals
 3. Control Wiring and Piping Diagrams
 4. Operating Instructions
 5. Copy of Guarantee
 6. Certificate of Instruction of Owner's Representative
 7. Certificate of Job Completion
 8. Record Documents
- B. Where projects are of sufficient size to make a single brochure impractical, several brochures shall be prepared by trade and As-Built Drawings may be submitted as a separate item.
- C. Brochure shall be indexed and divided for reasonable clarity.
- D. Brochure shall be turned over to the Architect/Engineer for review and approval. The contractor shall make modifications to the brochure as deemed necessary for compliance and clarity, by the Architect/Engineer, and re-submit the final brochure to the Architect/Engineer to be forwarded to the Owner.

END OF SECTION 22 00 00

SECTION 22 05 13
COMMON MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00.
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) requirements.

1.03 SUMMARY

- A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.04 COORDINATION

- A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
 - 1. Motor controllers.
 - 2. Torque, speed, and horsepower requirements of the load.
 - 3. Ratings and characteristics of supply circuit and required control sequence.
 - 4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.01 GENERAL MOTOR REQUIREMENTS

- A. Comply with NEMA MG 1 unless otherwise indicated.

2.02 MOTOR CHARACTERISTICS

- A. Duty: Continuous duty at ambient temperature of 40°C and at altitude of 3,300 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.

2.03 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. Rotor: Random-wound, squirrel cage.
- E. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
- F. Temperature Rise: Match insulation rating.
- G. Insulation: Class F.
- H. 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.

2.04 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:
 - 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.

2.05 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. Electronically Commutated Motor (ECM).
- 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.

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 22 05 13

SECTION 22 05 17
SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00.
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) requirements.

1.03 SUMMARY

- A. Section Includes:
 - 1. Sleeves.
 - 2. Sleeve-seal systems.
 - 3. Sleeve-seal fittings.
 - 4. Grout.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

PART 2 - PRODUCTS

2.01 SLEEVES

- 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. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
- E. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

2.02 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.

2.03 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.

2.04 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.

PART 3 - EXECUTION

3.01 SLEEVE INSTALLATION

- A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
- B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.
 - 1. Sleeves are not required for core-drilled holes.
- C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
 - 1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
 - 2. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.
 - 3. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.

- D. Install sleeves for pipes passing through interior partitions.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - 2. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Section 07 92 00 "Joint Sealants."
- E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 07 84 13 "Penetration Firestopping."

3.02 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.
- B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.03 SLEEVE-SEAL-FITTING INSTALLATION

- A. Install sleeve-seal fittings in new walls and slabs as they are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.
- C. Secure nailing flanges to concrete forms.
- D. Using grout, seal the space around outside of sleeve-seal fittings.

3.04 SLEEVE AND SLEEVE-SEAL SCHEDULE

- A. Use sleeves and sleeve seals for the following piping-penetration applications:
 - 1. Exterior Concrete Walls above Grade:
 - a. Piping Smaller Than NPS 6: Galvanized-steel wall sleeves.
 - b. Piping NPS 6 and Larger: Galvanized-steel wall sleeves.
 - 2. Exterior Concrete Walls below Grade:
 - a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
 - b. Piping NPS 6 and Larger: Galvanized-steel wall sleeves with sleeve-seal system.

- 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
3. Concrete Slabs-on-Grade:
- a. Piping Smaller Than NPS 6: Galvanized-steel wall sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
 - b. Piping NPS 6 and Larger: Galvanized-steel wall sleeves with sleeve-seal system Galvanized-steel-pipe sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
4. Interior Partitions:
- a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves.
 - b. Piping NPS 6 and Larger: Galvanized-steel-sheet sleeves.

END OF SECTION 22 05 17

SECTION 22 05 18
ESCUTCHEONS FOR PLUMBING PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00.
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) requirements.

1.03 SUMMARY

- A. Section Includes:
 - 1. Escutcheons.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

PART 2 - PRODUCTS

2.01 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.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.
- B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of insulated piping and with OD that completely covers opening.
 - 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 type with polished, chrome-plated finish.

- c. Insulated Piping: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed 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, cast-brass or split-casting brass type with polished, chrome-plated or rough-brass finish.
 - g. Bare Piping in Equipment Rooms: One-piece, cast-brass or split-casting brass type with polished, chrome-plated or rough-brass finish.
- C. Install floor plates for piping penetrations of equipment-room floors.
 - D. 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.

3.02 FIELD QUALITY CONTROL

- A. Replace broken and damaged escutcheons and floor plates using new materials.

END OF SECTION 22 05 18

SECTION 22 05 19
METERS AND GAGES FOR PLUMBING PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00.
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) requirements.

1.03 SUMMARY

- A. Section Includes:
 - 1. Liquid-in-glass thermometers.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

1.05 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of meter and gage, from manufacturer.

1.06 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.01 LIQUID-IN-GLASS THERMOMETERS

- A. Metal-Case, Compact-Style, Liquid-in-Glass Thermometers:
 - 1. Standard: ASME B40.200.
 - 2. Case: Cast aluminum; 6-inch nominal size.
 - 3. Case Form: Back angle unless otherwise indicated.
 - 4. Tube: Glass with magnifying lens and blue or red organic liquid.
 - 5. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in 2 F

6. Window: Glass or plastic.
7. Stem: Aluminum or brass and of length to suit installation.
 - a. Design for Thermowell Installation: Bare stem.
8. Connector: 3/4 inch, with ASME B1.1 screw threads.
9. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install valve and snubber in piping for each pressure gage for fluids.
- B. Install thermometers in the following locations:
 1. Inlet and outlet of each water heater.

3.02 CONNECTIONS

- A. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.

3.03 ADJUSTING

- A. Adjust faces of meters and gages to proper angle for best visibility.

3.04 THERMOMETER SCALE-RANGE SCHEDULE

- A. Scale Range for Domestic Cold-Water Piping: 0 to 100°F.
- B. Scale Range for Domestic Hot-Water Piping: 30 to 240°F.

END OF SECTION 22 05 19

SECTION 22 05 23.12
BALL VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00.
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) requirements.

1.03 SUMMARY

- A. Section Includes:
 - 1. Bronze ball valves.

1.04 DEFINITIONS

- A. CWP: Cold working pressure.

1.05 ACTION SUBMITTALS

- A. Product Data: For each type of valve.
 - 1. Certification that products comply with NSF 61 Annex G and NSF 372.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
 - 1. Protect internal parts against rust and corrosion.
 - 2. Protect threads, flange faces, and soldered ends.
 - 3. Set ball valves open to minimize exposure of functional surfaces.
- B. Use the following precautions during storage:
 - 1. Maintain valve end protection.
 - 2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
- C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use operating handles or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS FOR VALVES

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
- B. ASME Compliance:
 - 1. ASME B1.20.1 for threads for threaded end valves.
 - 2. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
 - 3. ASME B16.18 for solder-joint connections.
 - 4. ASME B31.9 for building services piping valves.
- C. NSF Compliance: NSF 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 Actuator Types:
 - 1. Handlever: For quarter-turn valves smaller than NPS 4.
- H. 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.

2.02 BRONZE BALL VALVES

- A. Two-Piece, Bronze Ball Valves with Full Port, and Bronze or Brass Trim:
 - 1. Description:
 - a. Standard: MSS SP-110.
 - b. CWP Rating: 400 psig.
 - c. Body Design: One piece.

- d. Body Material: Bronze.
- e. Ends: Threaded.
- f. Seats: PTFE.
- g. Stem: Bronze.
- h. Ball: Chrome-plated brass.
- i. Port: Full.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- E. Do not attempt to repair defective valves; replace with new valves.

3.02 VALVE INSTALLATION

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem movement.
- E. Install valve tags. Comply with requirements in Section 22 05 53 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.

3.03 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If valves with specified CWP ratings are unavailable, the same types of valves with higher CWP ratings may be substituted.
- B. Select valves with the following end connections:
 - 1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.

2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
3. For Copper Tubing, NPS 5 and Larger: Flanged ends.

3.04 DOMESTIC HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:

1. Bronze and Brass Valves: May be provided with solder-joint ends instead of threaded ends.
2. Two-piece, bronze ball valves with full port and bronze or brass trim.

END OF SECTION 22 05 23.12

SECTION 22 05 23.14
CHECK VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00.
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) requirements.

1.03 SUMMARY

- A. Section Includes:
 - 1. Bronze swing check valves.

1.04 DEFINITIONS

- A. CWP: Cold working pressure.
- B. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.

1.05 ACTION SUBMITTALS

- A. Product Data: For each type of valve.
 - 1. Certification that products comply with NSF 61 Annex G and NSF 372.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
 - 1. Protect internal parts against rust and corrosion.
 - 2. Protect threads, flange faces, grooves, and weld ends.
 - 3. Set check valves in either closed or open position.
- B. Use the following precautions during storage:
 - 1. Maintain valve end protection.
 - 2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

- C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS FOR VALVES

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
- B. 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.
- C. NSF Compliance: NSF 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.

2.02 BRONZE SWING CHECK VALVES

- A. Class 125, Bronze Swing Check Valves with Bronze Disc:
 - 1. Description:
 - a. Standard: MSS SP-80, Type 3.
 - b. CWP Rating: 200 psig.
 - c. Body Design: Horizontal flow.
 - d. Body Material: ASTM B 62, bronze.
 - e. Ends: Threaded or soldered. See valve schedule articles.
 - f. Disc: Bronze.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- E. Do not attempt to repair defective valves; replace with new valves.

3.02 VALVE INSTALLATION

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem movement.
- E. Install check valves for proper direction of flow and as follows:
 - 1. Swing Check Valves: In horizontal position with hinge pin level.
- F. Install valve tags. Comply with requirements in Section 22 05 53 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.

3.03 ADJUSTING

- A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.04 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If valves with specified CWP ratings are unavailable, the same types of valves with higher CWP ratings may be substituted.
- B. End Connections:
 - 1. For Copper Tubing, NPS 2 and Smaller: Threaded or soldered.
 - 2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged or threaded.
 - 3. For Copper Tubing, NPS 5 and Larger: Flanged.

3.05 DOMESTIC HOT- AND COLD-WATER VALVE SCHEDULE

- A. Pipe NPS 2 and Smaller: Bronze swing check valves, Class 125, bronze disc with threaded end connections.

END OF SECTION 22 05 23.14

SECTION 22 05 23.15
GATE VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00.
 - 1. Refer to "PART 2 – PRODUCTS" for all Buy America Build America Act (BABA) requirements.

1.03 SUMMARY

- A. Section Includes:
 - 1. Bronze gate valves.

1.04 DEFINITIONS

- A. CWP: Cold working pressure.
- B. NRS: Nonrising stem.
- C. OS&Y: Outside screw and yoke.
- D. RS: Rising stem.

1.05 ACTION SUBMITTALS

- A. Product Data: For each type of valve.
 - 1. Certification that products comply with NSF 61 Annex G and NSF 372.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
 - 1. Protect internal parts against rust and corrosion.
 - 2. Protect threads, flange faces, grooves, and weld ends.
 - 3. Set gate valves closed to prevent rattling.
- B. Use the following precautions during storage:
 - 1. Maintain valve end protection.

2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS FOR VALVES

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
- B. 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.
- C. NSF Compliance: NSF 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. RS Valves in Insulated Piping: With 2-inch stem extensions.
- H. Valve Bypass and Drain Connections: MSS SP-45.

2.02 BRONZE GATE VALVES

- A. Class 125, NRS, Bronze Gate Valves:
 1. Description:
 - a. Standard: MSS SP-80, Type 1.
 - b. CWP Rating: 200 psig.
 - c. Body Material: Bronze with integral seat and union-ring bonnet.
 - d. Ends: Threaded.
 - e. Stem: Bronze.

- f. Disc: Solid wedge; bronze.
- g. Packing: Asbestos free.
- h. Handwheel: Malleable iron, bronze, or aluminum.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. Do not attempt to repair defective valves; replace with new valves.

3.02 VALVE INSTALLATION

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem movement.
- E. Install valve tags. Comply with requirements in Section 22 05 53 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.

3.03 ADJUSTING

- A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.04 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. Use gate valves for shutoff service only.
- B. If valves with specified CWP ratings are unavailable, the same types of valves with higher CWP ratings may be substituted.

3.05 DOMESTIC HOT- AND COLD-WATER VALVE SCHEDULE

- A. Pipe NPS 2 and Smaller: Bronze gate valves, Class 125, NRS with threaded ends.
- B. Pipe NPS 2-1/2 and Larger: Bronze gate valves, Class 125, NRS with threaded ends.

END OF SECTION 22 05 23.15

SECTION 22 05 29
HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00.
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) requirements.

1.03 SUMMARY

- A. Section Includes:
 - 1. Metal pipe hangers and supports.
 - 2. Trapeze pipe hangers.
 - 3. Thermal-hanger shield inserts.
 - 4. Fastener systems.
 - 5. Pipe positioning systems.
 - 6. Equipment supports.
- B. Related Sections:
 - 1. Section 05 50 00 “Metal Fabrications” for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.

1.04 DEFINITIONS

- A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.

1.05 PERFORMANCE REQUIREMENTS

- A. Structural Performance: 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/SEI 7.
 - 1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
 - 2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.06 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Show fabrication and installation details and include calculations for the following; include Product Data for components:
 - 1. Trapeze pipe hangers.
 - 2. Equipment supports.

1.07 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

1.08 QUALITY ASSURANCE

- A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.01 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. Copper Pipe Hangers:
 - 1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
 - 2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel.

2.02 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 galvanized-steel hanger rods, nuts, saddles, and U-bolts.

2.03 THERMAL-HANGER SHIELD INSERTS

- A. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig minimum compressive strength and vapor barrier.
- B. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate 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.

2.04 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 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.

2.05 PIPE POSITIONING SYSTEMS

- A. Description: IAPMO PS 42, positioning system of metal brackets, clips, and straps for positioning piping in pipe spaces; for plumbing fixtures in commercial applications.

2.06 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.07 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.
- B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
 - 1. Properties: Nonstaining, noncorrosive, and nongaseous.
 - 2. Design Mix: 5000-psi, 28-day compressive strength.
 - 3. Max. VOC content = 65g/L.

PART 3 - EXECUTION

3.01 HANGER AND SUPPORT INSTALLATION

- A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.
- B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
 - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
 - 2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- C. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- D. Fastener System Installation:
 - 1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
 - 2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- E. Pipe Positioning-System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture.
- F. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- G. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- H. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- I. Install lateral bracing with pipe hangers and supports to prevent swaying.
- J. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- K. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

- L. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.
- M. Insulated Piping:
 - 1. Attach clamps and spacers to piping.
 - a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
 - b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
 - c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
 - 2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 - 3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 - 4. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
 - b. NPS 4: 12 inches long and 0.06 inch thick.
 - c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
 - d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
 - e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.
 - 5. Pipes NPS 8 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
 - 6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.02 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make bearing surface smooth.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.03 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.04 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.05 PAINTING

- A. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Section 09 91 13 "Exterior Painting." Section 09 91 23 "Interior Painting." Section 09 96 00 "High-Performance Coatings."
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.06 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

- E. Use carbon-steel pipe hangers and supports and metal trapeze pipe hangers and attachments for general service applications.
- F. Use stainless-steel pipe hangers and stainless-steel attachments for hostile environment applications.
- G. Use copper-plated pipe hangers and copper attachments for copper piping and tubing.
- H. Use padded hangers for piping that is subject to scratching.
- I. Use thermal-hanger shield inserts for insulated piping and tubing.
- J. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
 - 2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F, pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.
 - 3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
 - 4. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
 - 5. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
 - 6. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
 - 7. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
 - 8. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
 - 9. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
- K. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
 - 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

- L. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
 2. Steel Clevises (MSS Type 14): For 120 to 450°F piping installations.
- M. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joint construction, to attach to top flange of structural shape.
 3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 6. C-Clamps (MSS Type 23): For structural shapes.
 7. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - a. Light (MSS Type 31): 750 lb
 - b. Medium (MSS Type 32): 1500 lb.
 - c. Heavy (MSS Type 33): 3000 lb.
 8. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
 9. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
- N. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- O. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
 2. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
 3. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
- P. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
- Q. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.
- R. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

END OF SECTION 22 05 29

SECTION 22 05 48.13
VIBRATION CONTROLS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00.
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) requirements.

1.03 SUMMARY

- A. Section Includes:
 - 1. Elastomeric isolation pads.
 - 2. Open-spring isolators.
 - 3. Restrained-spring isolators.
 - 4. Pipe-riser resilient supports.
 - 5. Spring hangers.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Delegated-Design Submittal: For each vibration isolation device.
 - 1. Include design calculations for selecting vibration isolators.

PART 2 - PRODUCTS

2.01 ELASTOMERIC ISOLATION PADS

- A. Elastomeric Isolation Pads:
 - 1. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
 - 2. Size: Factory or field cut to match requirements of supported equipment.
 - 3. Pad Material: Oil and water resistant with elastomeric properties.
 - 4. Surface Pattern: Ribbed pattern.

5. Infused nonwoven cotton or synthetic fibers.
6. Load-bearing metal plates adhered to pads.

2.02 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.

2.03 PIPE-RISER RESILIENT SUPPORT

- A. Provide 1" neoprene pad under floor pipe clam. Provide 1/4" metal plate under and on top of neoprene pad.

PART 3 - EXECUTION

3.01 VIBRATION CONTROL DEVICE INSTALLATION

- A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 03 30 00 "Cast-in-Place Concrete."
- B. Installation of vibration isolators must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.

END OF SECTION 22 05 48.13

SECTION 22 05 53
IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00.
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) requirements.

1.03 SUMMARY

- A. Section Includes:
 - 1. Equipment labels.
 - 2. Pipe labels.
 - 3. Valve tags.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples: For color, letter style, and graphic representation required for each identification material and device.
- C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
- D. Valve numbering scheme.
- E. Valve Schedules: For each piping system to include in maintenance manuals.

PART 2 - PRODUCTS

2.01 EQUIPMENT LABELS

- A. 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. Letter Color: White.
 - 3. Background Color: Black.

4. Maximum Temperature: Able to withstand temperatures up to 160°F.
 5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
 6. 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.
 7. Fasteners: Stainless-steel self-tapping screws.
 8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- B. Label Content: Include equipment's Drawing designation or unique equipment number.
- C. 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.

2.02 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 partially cover 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; 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.

2.03 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 minimum thickness, and having predrilled or stamped holes for attachment hardware.
 2. Fasteners: Brass 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. Valve-tag schedule shall be included in operation and maintenance data.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.02 GENERAL INSTALLATION REQUIREMENTS

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

3.03 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

3.04 PIPE LABEL INSTALLATION

- A. Pipe Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 - 1. Near each valve and control device.
 - 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 - 3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
 - 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 - 5. Near major equipment items and other points of origination and termination.
 - 6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
 - 7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

- B. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.
- C. Pipe Label Color Schedule:
 - 1. Domestic Water Piping
 - a. Background: Safety green.
 - b. Letter Colors: White.
 - 2. Sanitary Waste and Storm Drainage Piping:
 - a. Background Color: Safety gray
 - b. Letter Color: Black.

3.05 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, shutoff valves, faucets, convenience and lawn-watering hose connections, and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.
- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:
 - 1. Valve-Tag Size and Shape: 1-1/2 inches.
 - 2. Valve-Tag Colors: Natural
 - 3. Letter Colors: Black.

END OF SECTION 22 05 53

SECTION 22 07 19
PLUMBING PIPING INSULATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00.
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) requirements.

1.03 SUMMARY

- A. Section includes insulating the following plumbing piping services:
 - 1. Domestic hot-water piping.
 - 2. Domestic recirculating hot-water piping.
 - 3. Roof drains and rainwater leaders.
 - 4. Supplies and drains for handicap-accessible lavatories and sinks.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied, if any).
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
 - 2. Detail attachment and covering of heat tracing inside insulation.
 - 3. Detail insulation application at pipe expansion joints for each type of insulation.
 - 4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
 - 5. Detail removable insulation at piping specialties, equipment connections, and access panels.
 - 6. Detail application of field-applied jackets.
 - 7. Detail application at linkages of control devices.

1.05 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.
- C. Field quality-control reports.

1.06 QUALITY ASSURANCE

- A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84 by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
 - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.
- B. Comply with the following applicable standards and other requirements specified for miscellaneous components:
 - 1. Supply and Drain Protective Shielding Guards: ICC A117.1.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.08 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 22 05 29 "Hangers and Supports for Plumbing Piping and Equipment."
- B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
- C. Coordinate installation and testing of heat tracing.

1.09 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.01 INSULATION MATERIALS

- A. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- B. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- C. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- D. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- E. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in “Factory-Applied Jackets” Article.
 - 1. Block Insulation: ASTM C 552, Type I.
 - 2. Special-Shaped Insulation: ASTM C 552, Type III.
 - 3. Preformed Pipe Insulation without Jacket: Comply with ASTM C 552, Type II, Class 1.
 - 4. Preformed Pipe Insulation with Factory-Applied ASJ-SSL: Comply with ASTM C 552, Type II, Class 2.
 - 5. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
- F. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.
- G. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type I. Factory-applied jacket requirements are specified in “Factory-Applied Jackets” Article.
- H. Mineral-Fiber, Preformed Pipe Insulation:
 - 1. Type I, 850°F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in “Factory-Applied Jackets” Article.

2.02 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.

- B. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
 - 1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
 - 1. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- D. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
 - 1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.03 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
 - 1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.
 - 1. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
 - 2. Service Temperature Range: Minus 20 to plus 180°F.
 - 3. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
 - 4. Color: White.

2.04 LAGGING ADHESIVES

- A. Description: Comply with MIL-A-3316C, Class I, Grade A, and shall be compatible with insulation materials, jackets, and substrates.
 - 1. For indoor applications, use lagging adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 2. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over pipe insulation.
 - 3. Service Temperature Range: 0 to plus 180°F.
 - 4. Color: White.

2.05 SEALANTS

- A. Joint Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
 2. Permanently flexible, elastomeric sealant.
 3. Service Temperature Range: Minus 100 to plus 300°F.
 4. Color: White or gray.
 5. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
1. Materials shall be compatible with insulation materials, jackets, and substrates.
 2. Fire- and water-resistant, flexible, elastomeric sealant.
 3. Service Temperature Range: Minus 40 to plus 250°F.
 4. Color: White.
 5. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.06 FACTORY-APPLIED JACKETS

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
 2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.

2.07 FIELD-APPLIED CLOTHS

- A. Woven Glass-Fiber Fabric: Comply with MIL-C-20079H, Type I, plain weave, and presized a minimum of 8 oz./sq. yd..

2.08 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. Underground Direct-Buried Jacket: 125-mil- thick vapor barrier and waterproofing membrane consisting of a rubberized bituminous resin reinforced with a woven-glass fiber or polyester scrim and laminated aluminum foil.

2.09 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
1. Width: 3 inches.

2. Thickness: 11.5 mils.
3. Adhesion: 90 ounces force/inch in width.
4. Elongation: 2 percent.
5. Tensile Strength: 40 lbf/inch in width.
6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

2.10 SECUREMENTS

- A. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.

2.11 PROTECTIVE SHIELDING GUARDS

- A. Protective Shielding Pipe Covers,:
 1. Description: Manufactured plastic wraps for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with Department of Justice's Americans with Disabilities Act (ADA) Standards for Accessible Design (ADAS) requirements.
- B. Protective Shielding Piping Enclosures,:
 1. Description: Manufactured plastic enclosure for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with Comply with Department of Justice's Americans with Disabilities Act (ADA) Standards for Accessible Design (ADAS) requirements.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
 1. Verify that systems to be insulated have been tested and are free of defects.
 2. Verify that surfaces to be insulated are clean and dry.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:
 1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils thick and an epoxy finish 5 mils thick if operating in a temperature range between 140

and 300°F. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

2. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300°F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
- C. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
 - D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.03 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during application and finishing.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.
- J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 1. Install insulation continuously through hangers and around anchor attachments.
 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- L. Install insulation with factory-applied jackets as follows:
1. Draw jacket tight and smooth.
 2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
 - a. For below-ambient services, apply vapor-barrier mastic over staples.
 4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.
- M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- P. For above-ambient services, do not install insulation to the following:
1. Vibration-control devices.
 2. Testing agency labels and stamps.
 3. Nameplates and data plates.
 4. Cleanouts.

3.04 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
1. Seal penetrations with flashing sealant.

2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
 4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.
- C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
1. Seal penetrations with flashing sealant.
 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
 4. Seal jacket to wall flashing with flashing sealant.
- D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
1. Comply with requirements in Section 078413 “Penetration Firestopping” for firestopping and fire-resistive joint sealers.
- F. Insulation Installation at Floor Penetrations:
1. Pipe: Install insulation continuously through floor penetrations.
 2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 “Penetration Firestopping.”

3.05 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.

2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
 3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
 4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
 5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
 6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
 7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
 8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
 9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.
- C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
- D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.06 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

- A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- B. Insulation Installation on Pipe Flanges:
 1. Install pipe insulation to outer diameter of pipe flange.
 2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
 4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- C. Insulation Installation on Pipe Fittings and Elbows:
 1. Install mitered sections of pipe insulation.
 2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.
2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.07 INSTALLATION OF MINERAL-FIBER INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

- D. Insulation Installation on Valves and Pipe Specialties:
 - 1. Install preformed sections of same material as straight segments of pipe insulation when available.
 - 2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
 - 3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 - 4. Install insulation to flanges as specified for flange insulation application.

3.08 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform tests and inspections.
- C. Tests and Inspections:
 - 1. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect-Engineer, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the “Piping Insulation Schedule, General” Article.
- D. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.09 PIPING INSULATION SCHEDULE, GENERAL

- A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.
- B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
 - 1. Underground piping.
 - 2. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.10 INDOOR PIPING INSULATION SCHEDULE

- A. Domestic Hot and Recirculated Hot Water:
 - 1. NPS 1-1/4 and Smaller: Insulation shall be one of the following:
 - a. Flexible Elastomeric: 1 inch thick.
 - b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

2. NPS 1-1/2 and Larger: Insulation shall be one of the following:
 - a. Flexible Elastomeric: 1 inch thick.
 - b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
- B. Stormwater and Overflow:
 1. All Pipe Sizes: Insulation shall be one of the following:
 - a. Flexible Elastomeric: 1 inch thick.
 - b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
- C. Roof Drain and Overflow Drain Bodies:
 1. All Pipe Sizes: Insulation shall be one of the following:
 - a. Flexible Elastomeric: 1 inch thick.
 - b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

3.11 INDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Piping, Concealed:
 1. None.
- D. Piping, Exposed:
 1. None.

END OF SECTION 22 07 19

SECTION 22 11 16
DOMESTIC WATER PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00.
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) requirements.

1.03 SUMMARY

- A. Section Includes:
 - 1. Under-building-slab and aboveground domestic water pipes, tubes, and fittings inside buildings.

1.04 ACTION SUBMITTALS

- A. Product Data: For transition fittings and dielectric fittings.

1.05 INFORMATIONAL SUBMITTALS

- A. System purging and disinfecting activities report.
- B. Field quality-control reports.

PART 2 - PRODUCTS

2.01 PIPING MATERIALS

- A. 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.
- B. Potable-water piping and components shall comply with NSF 14 and NSF 61 Annex G. Plastic piping components shall be marked with “NSF-pw.”

2.02 COPPER TUBE AND FITTINGS

- A. Hard Copper Tube: ASTM B 88, Type L water tube, drawn temper.
- B. Soft Copper Tube: ASTM B 88, Type L water tube, annealed temper.
- C. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.

- D. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
- E. Copper Unions:
 - 1. MSS SP-123.
 - 2. Cast-copper-alloy, hexagonal-stock body.
 - 3. Ball-and-socket, metal-to-metal seating surfaces.
 - 4. Solder-joint or threaded ends.
- F. Copper Pressure-Seal-Joint Fittings:
 - 1. Fittings for NPS 2 and Smaller: Wrought-copper fitting with EPDM-rubber, O-ring seal in each end.
 - 2. Fittings for NPS 2-1/2 to NPS 4: Cast-bronze or wrought-copper fitting with EPDM-rubber, O-ring seal in each end.
- G. Copper Push-on-Joint Fittings:
 - 1. Description:
 - a. Cast-copper fitting complying with ASME B16.18 or wrought-copper fitting complying with ASME B 16.22.
 - b. Stainless-steel teeth and EPDM-rubber, O-ring seal in each end instead of solder-joint ends.

2.03 TRANSITION FITTINGS

- A. General Requirements:
 - 1. Same size as pipes to be joined.
 - 2. Pressure rating at least equal to pipes to be joined.
 - 3. End connections compatible with pipes to be joined.
- B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

2.04 DIELECTRIC FITTINGS

- A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
- B. Dielectric Unions:
 - 1. Standard: ASSE 1079.
 - 2. Pressure Rating: 125 psig minimum at 180 deg F.

3. End Connections: Solder-joint copper alloy and threaded ferrous.
- C. Dielectric Flanges:
1. Standard: ASSE 1079.
 2. Factory-fabricated, bolted, companion-flange assembly.
 3. Pressure Rating: 125 psig minimum at 180 deg F.
 4. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.
- D. Dielectric-Flange Insulating Kits:
1. Nonconducting materials for field assembly of companion flanges.
 2. Pressure Rating: 150 psig.
 3. Gasket: Neoprene or phenolic.
 4. Bolt Sleeves: Phenolic or polyethylene.
 5. Washers: Phenolic with steel backing washers.
- E. Dielectric Nipples:
1. Standard: IAPMO PS 66.
 2. Electroplated steel nipple complying with ASTM F 1545.
 3. Pressure Rating and Temperature: 300 psig at 225°F.
 4. End Connections: Male threaded or grooved.
 5. Lining: Inert and noncorrosive, propylene.

PART 3 - EXECUTION

3.01 EARTHWORK

- A. Comply with requirements in Section 31 20 00 "Earth Moving" for excavating, trenching, and backfilling.

3.02 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. 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.
- B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."
- C. Install ductile-iron piping under building slab with restrained joints according to AWWA C600 and AWWA M41.

- D. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve inside the building at each domestic water-service entrance. Comply with requirements for pressure gages in Section 220519 “Meters and Gages for Plumbing Piping” and with requirements for drain valves and strainers in Section 22 11 19 “Domestic Water Piping Specialties.”
- E. Install shutoff valve immediately upstream of each dielectric fitting.
- F. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- G. 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.
- H. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.
- I. Install piping to permit valve servicing.
- J. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.
- K. Install piping free of sags and bends.
- L. Install fittings for changes in direction and branch connections.
- M. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.
- N. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 22 05 17 “Sleeves and Sleeve Seals for Plumbing Piping.”
- O. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 22 05 17 “Sleeves and Sleeve Seals for Plumbing Piping.”
- P. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 22 05 18 “Escutcheons for Plumbing Piping.”

3.03 JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads.
 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- D. Brazed Joints for Copper Tubing: Comply with CDA's "Copper Tube Handbook," "Braze Joints" chapter.
- E. Soldered Joints for Copper Tubing: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."
- F. Pressure-Sealed Joints for Copper Tubing: Join copper tube and pressure-seal fittings with tools recommended by fitting manufacturer.
- G. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.
- H. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.

3.04 TRANSITION FITTING INSTALLATION

- A. Install transition couplings at joints of dissimilar piping.
- B. Transition Fittings in Underground Domestic Water Piping:
1. Fittings for NPS 1-1/2 and Smaller: Fitting-type coupling.
 2. Fittings for NPS 2 and Larger: Sleeve-type coupling.

3.05 DIELECTRIC FITTING INSTALLATION

- A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

3.06 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements for pipe hanger, support products, and installation in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
- B. Support vertical piping and tubing at base and at each floor.
- C. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch.
- D. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.
 2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
 3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
 4. NPS 2-1/2: 108 inches with 1/2-inch rod.

5. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
 6. NPS 6: 10 feet with 5/8-inch rod.
 7. NPS 8: 10 feet with 3/4-inch rod.
- E. Install supports for vertical copper tubing every 10 feet.
- F. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1-1/4 and Smaller: 84 inches with 3/8-inch rod.
 2. NPS 1-1/2: 108 inches with 3/8-inch rod.
 3. NPS 2: 10 feet with 3/8-inch rod.
 4. NPS 2-1/2: 11 feet with 1/2-inch rod.
 5. NPS 3 and NPS 3-1/2: 12 feet with 1/2-inch rod.
 6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.
 7. NPS 6: 12 feet with 3/4-inch rod.
 8. NPS 8 to NPS 12: 12 feet with 7/8-inch rod.
- G. Install supports for vertical steel piping every 15 feet.
- H. Support piping and tubing not listed in this article according to MSS SP-69 and manufacturer's written instructions.

3.07 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.
- C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.
- D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:
1. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
 2. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code.
 3. Equipment: Cold- and hot-water-supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

3.08 IDENTIFICATION

- A. Identify system components. Comply with requirements for identification materials and installation in Section 22 05 53 “Identification for Plumbing Piping and Equipment.”
- B. Label pressure piping with system operating pressure.

3.09 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Piping Inspections:
 - a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
 - b. During installation, notify authorities having jurisdiction at least one day 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 authorities having jurisdiction to observe tests specified in “Piping Tests” Subparagraph below and to ensure compliance with requirements.
 - c. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
 - d. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
 - 2. Piping Tests:
 - a. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
 - b. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
 - c. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 - d. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.

- e. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
 - f. Prepare reports for tests and for corrective action required.
- B. Domestic water piping will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

3.10 ADJUSTING

- A. Perform the following adjustments before operation:
- 1. Close drain valves, hydrants, and hose bibbs.
 - 2. Open shutoff valves to fully open position.
 - 3. Open throttling valves to proper setting.
 - 4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
 - a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide hot-water flow in each branch.
 - b. Adjust calibrated balancing valves to flows indicated.
 - 5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
 - 6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
 - 7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
 - 8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.11 CLEANING

- A. Clean and disinfect potable domestic water piping as follows:
- 1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
 - 2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
 - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
 - b. Fill and isolate system according to either of the following:

- 1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
 - 2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.
- c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
 - d. Repeat procedures if biological examination shows contamination.
 - e. Submit water samples in sterile bottles to authorities having jurisdiction.
- B. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.
- C. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.12 PIPING SCHEDULE

- A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
- B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.
- C. Fitting Option: Extruded-tee connections and brazed joints may be used on aboveground copper tubing.
- D. Aboveground domestic water piping, NPS 2 and smaller, shall be one of the following:
1. Hard copper tube, ASTM B 88, Type L; wrought-copper, solder-joint fittings; and soldered joints.
 2. Hard copper tube, ASTM B 88, Type L; copper pressure-seal-joint fittings; and pressure-sealed joints.
- E. Aboveground domestic water piping, NPS 2-1/2 to NPS 4, shall be one of the following:
1. Hard copper tube, ASTM B 88, Type L; wrought-copper, solder-joint fittings; and soldered joints.
 2. Hard copper tube, ASTM B 88, Type L; copper pressure-seal-joint fittings; and pressure-sealed joints.

END OF SECTION 22 11 16

SECTION 22 11 19
DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00.
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) requirements.

1.03 SUMMARY

- A. Section Includes:
 - 1. Vacuum breakers.
 - 2. Backflow preventers.
 - 3. Water pressure-reducing valves.
 - 4. Balancing valves.
 - 5. Temperature-actuated, water mixing valves.
 - 6. Strainers.
 - 7. Hose bibbs.
 - 8. Water-hammer arresters.
 - 9. Trap-seal primer valves.
- B. Related Requirements:
 - 1. Section 22 05 19 “Meters and Gages for Plumbing Piping” for thermometers, pressure gages, and flow meters in domestic water piping.
 - 2. Section 22 11 16 “Domestic Water Piping” for water meters.
 - 3. Section 22 47 16 “Pressure Water Coolers” for water filters for water coolers.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For domestic water piping specialties.

1. Include diagrams for power, signal, and control wiring.

1.05 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.06 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS FOR PIPING SPECIALTIES

- A. Potable-water piping and components shall comply with NSF 61 Annex G and NSF 14

2.02 PERFORMANCE REQUIREMENTS

- A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig unless otherwise indicated.

2.03 VACUUM BREAKERS

- A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:

1. Standard: ASSE 1001.
2. Size: NPS 1/4 to NPS 3, as required to match connected piping.
3. Body: Bronze.
4. Inlet and Outlet Connections: Threaded.
5. Finish: Rough bronze.

- B. Hose-Connection Vacuum Breakers:

1. Standard: ASSE 1011.
2. Body: Bronze, nonremovable, with manual drain.
3. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.
4. Finish: Rough bronze.

2.04 BACKFLOW PREVENTERS

- A. Reduced-Pressure-Principle Backflow Preventers:

1. Standard: ASSE 1013.
2. Operation: Continuous-pressure applications.

2.05 BALANCING VALVES

A. Memory-Stop Balancing Valves:

1. Standard: MSS SP-110 for two-piece, copper-alloy ball valves.
2. Pressure Rating: 400-psig minimum CWP.
3. Size: NPS 2 or smaller.
4. Body: Copper alloy.
5. Port: Standard or full port.
6. Ball: Chrome-plated brass.
7. Seats and Seals: Replaceable.
8. End Connections: Solder joint or threaded.
9. Handle: Vinyl-covered steel with memory-setting device.

2.06 STRAINERS FOR DOMESTIC WATER PIPING

A. Y-Pattern Strainers:

1. Pressure Rating: 125 psig minimum unless otherwise indicated.
2. Body: Bronze for NPS 2 and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved, epoxy coated and for NPS 2-1/2 and larger.
3. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
4. Screen: Stainless steel with round perforations unless otherwise indicated.
5. Perforation Size:
 - a. Strainers NPS 2 and Smaller: 0.033 inch.
 - b. Strainers NPS 2-1/2 to NPS 4: 0.062 inch.
 - c. Strainers NPS 5 and Larger: 0.125 inch.
6. Drain: Factory-installed, hose-end drain valve.

2.07 HOSE BIBBS

A. Hose Bibbs:

1. Standard: ASME A112.18.1 for sediment faucets.
2. Body Material: Bronze.

3. Seat: Bronze, replaceable.
4. Supply Connections: NPS 1/2 or NPS 3/4 threaded or solder-joint inlet.
5. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
6. Pressure Rating: 125 psig.
7. Vacuum Breaker: Integral or field-installation, nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
8. Finish for Equipment Rooms: Rough bronze, or chrome or nickel plated.
9. Finish for Service Areas: Rough bronze.
10. Finish for Finished Rooms: Chrome or nickel plated.
11. Operation for Equipment Rooms: Wheel handle or operating key.
12. Operation for Service Areas: Wheel handle.
13. Operation for Finished Rooms: Operating key.
14. Include operating key with each operating-key hose bibb.
15. Include integral wall flange with each chrome- or nickel-plated hose bibb.

2.08 WATER-HAMMER ARRESTERS

A. Water-Hammer Arresters :

1. Standard: ASSE 1010 or PDI-WH 201.
2. Type: Copper tube with piston.
3. Size: ASSE 1010, Sizes AA and A through F, or PDI-WH 201, Sizes A through F.

2.09 TRAP-SEAL PRIMER DEVICE

A. Supply-Type, Trap-Seal Primer Device:

1. Standard: ASSE 1018.
2. Pressure Rating: 125 psig minimum.
3. Body: Bronze.
4. Inlet and Outlet Connections: NPS 1/2 threaded, union, or solder joint.
5. Gravity Drain Outlet Connection: NPS 1/2 threaded or solder joint.
6. Finish: Chrome plated, or rough bronze for units used with pipe or tube that is not chrome finished.

B. Drainage-Type, Trap-Seal Primer Device :

1. Standard: ASSE 1044, lavatory P-trap with NPS 3/8 minimum, trap makeup connection.
2. Size: NPS 1-1/4 minimum.
3. Material: Chrome-plated, cast brass.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.
 1. Locate backflow preventers in same room as connected equipment or system.
 2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe-to-floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are unacceptable for this application.
 3. Do not install bypass piping around backflow preventers.
- B. Install water regulators with inlet and outlet shutoff valves. Install pressure gages on inlet and outlet.
- C. Install balancing valves in locations where they can easily be adjusted.
- D. Install temperature-actuated, water mixing valves with check stops or shutoff valves on inlets and with shutoff valve on outlet.
 1. Install cabinet-type units recessed in or surface mounted on wall as specified.
- E. Install Y-pattern strainers for water on supply side of each water pressure-reducing valve and pump.
- F. Install water-hammer arresters in water piping according to PDI-WH 201.
- G. Install air vents at high points of water piping.
- H. Install supply-type, trap-seal primer valves with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow.
- I. Install drainage-type, trap-seal primer valves as lavatory trap with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting.

3.02 CONNECTIONS

- A. Comply with requirements for ground equipment in Section 26 05 26 "Grounding and Bonding for Electrical Systems."

- B. Fire-retardant-treated-wood blocking is specified in Section 26 05 19 “Low-Voltage Electrical Power Conductors and Cables” for electrical connections.

3.03 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Test each reduced-pressure-principle backflow preventer according to authorities having jurisdiction and the device's reference standard.
- B. Domestic water piping specialties will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

3.04 ADJUSTING

- A. Set field-adjustable pressure set points of water pressure-reducing valves.
- B. Set field-adjustable flow set points of balancing valves.
- C. Set field-adjustable temperature set points of temperature-actuated, water mixing valves.

END OF SECTION 22 11 19

SECTION 22 13 16
SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00.
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) requirements.

1.03 SUMMARY

- A. Section Includes:
 - 1. Pipe, tube, and fittings.
 - 2. Specialty pipe fittings.
 - 3. Encasement for underground metal piping.

1.04 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:
 - 1. Soil, Waste, and Vent Piping: 10-foot head of water.
 - 2. Waste Piping: 100 psig.

1.05 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

1.06 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.07 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF/ANSI 14, “Plastics Piping Systems Components and Related Materials,” for plastic piping components. Include marking with “NSF-dwv” for plastic drain, waste, and vent piping and “NSF-sewer” for plastic sewer piping.

PART 2 - PRODUCTS

2.01 PIPING MATERIALS

- A. 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.

2.02 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A 74, Service class.
- B. Gaskets: ASTM C 564, rubber.

2.03 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A 888 or CISPI 301.
- B. CISPI, Hubless-Piping Couplings:
 - 1. Standards: ASTM C 1277 and CISPI 310.
 - 2. Description: Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.
- C. Heavy-Duty, Hubless-Piping Couplings:
 - 1. Standards: ASTM C 1277 and ASTM C 1540.
 - 2. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.04 COPPER TUBE AND FITTINGS

- A. Copper DWV Tube: ASTM B 306, drainage tube, drawn temper.
- B. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.
- C. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.
 - 1. Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
 - 2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
- D. Solder: ASTM B 32, lead free with ASTM B 813, water-flushable flux.

2.05 PVC PIPE AND FITTINGS

- A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.
- B. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.

- C. Adhesive Primer: ASTM F 656.
 - 1. Adhesive primer shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- D. Solvent Cement: ASTM D 2564.
 - 1. PVC solvent cement shall have a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.06 SPECIALTY PIPE FITTINGS

- A. Transition Couplings:
 - 1. General Requirements: Fitting or device for joining piping with small differences in OD's or of different materials. Include end connections same size as and compatible with pipes to be joined.

PART 3 - EXECUTION

3.01 EARTH MOVING

- A. Comply with requirements for excavating, trenching, and backfilling specified in Section 31 20 00 "Earth Moving."

3.02 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. 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. 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. 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. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

- K. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.
- L. Install soil and waste drainage and vent piping at the following minimum slopes unless otherwise indicated:
 - 1. Building Sanitary Drain: 1/4" per foot downward in direction of flow for piping NPS 2 and smaller; 1/8" per foot downward in direction of flow for piping NPS 2-1/2 and larger.
 - 2. Vent Piping: 1/8" per foot 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."
- N. Install aboveground copper tubing according to CDA's "Copper Tube Handbook."
- O. Install aboveground PVC piping according to ASTM D 2665.
- P. Install underground PVC piping according to ASTM D 2321.
- Q. Plumbing Specialties:
 - 1. Install backwater valves in sanitary waster gravity-flow piping. Comply with requirements for backwater valves specified in Section 22 13 19 "Sanitary Waste Piping Specialties."
 - 2. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary drainage gravity-flow piping. Install cleanout fitting with closure plug inside the building in sanitary drainage force-main piping. Comply with requirements for cleanouts specified in Section 22 13 19 "Sanitary Waste Piping Specialties."
 - 3. Install drains in sanitary drainage gravity-flow piping. Comply with requirements for drains specified in Section 22 13 19 "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. Comply with requirements for sleeves specified in Section 22 05 17 "Sleeves and Sleeve Seals for Plumbing Piping."

- T. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 22 05 17 “Sleeves and Sleeve Seals for Plumbing Piping.”
- U. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 22 05 18 “Escutcheons for Plumbing Piping.”

3.03 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. Join copper tube and fittings with soldered joints according to ASTM B 828. Use ASTM B 813, water-flushable, lead-free flux and ASTM B 32, lead-free-alloy solder.
- D. 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.
- E. Plastic, Nonpressure-Piping, Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
 - 1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
 - 2. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 Appendixes.

3.04 SPECIALTY PIPE FITTING INSTALLATION

- A. Transition Couplings:
 - 1. Install transition couplings at joints of piping with small differences in OD’s.
 - 2. In Drainage Piping: Unshielded, nonpressure transition couplings.

3.05 VALVE INSTALLATION

- A. General valve installation requirements are specified in Section 22 05 23.12 “Ball Valves for Plumbing Piping,” Section 22 05 23.14 “Check Valves for Plumbing Piping,” and Section 22 05 23.15 “Gate Valves for Plumbing Piping.”
- B. Shutoff Valves:
 - 1. Install shutoff valve on each sewage pump discharge.
 - 2. Install gate or full-port ball valve for piping NPS 2 and smaller.
 - 3. Install gate valve for piping NPS 2-1/2 and larger.

- C. Check Valves: Install swing check valve, between pump and shutoff valve, on each sewage pump discharge.
- D. Backwater Valves: Install backwater valves in piping subject to backflow.
 - 1. Horizontal Piping: Horizontal backwater valves. Use normally closed type unless otherwise indicated.
 - 2. Floor Drains: Drain outlet backwater valves unless drain has integral backwater valve.
 - 3. Install backwater valves in accessible locations.
 - 4. Comply with requirements for backwater valve specified in Section 22 13 19 "Sanitary Waste Piping Specialties."

3.06 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements for pipe hanger and support devices and installation specified in Section 22 05 29 "Hangers and Supports for Plumbing Piping and Equipment."
 - 1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
 - 2. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
 - 3. Vertical Piping: MSS Type 8 or Type 42, clamps.
 - 4. 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.
 - 5. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 - 6. 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. 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. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1-1/4: 72 inches with 3/8-inch rod.
 2. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
 3. NPS 2-1/2: 108 inches with 1/2-inch rod.
 4. NPS 3 and NPS 5: 10 feet with 1/2-inch rod.
 5. NPS 6: 10 feet with 5/8-inch rod.
- H. Install supports for vertical copper tubing every 10 feet.
- I. Install hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1-1/2 and NPS 2: 48 inches with 3/8-inch rod.
 2. NPS 3: 48 inches with 1/2-inch rod.
 3. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
 4. NPS 6 and NPS 8: 48 inches with 3/4-inch rod.
 5. NPS 10 and NPS 12: 48 inches with 7/8-inch rod.
- J. Install supports for vertical PVC piping every 48 inches.
- K. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.07 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 drainage and vent piping to the following:
1. Plumbing Fixtures: Connect drainage 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 drainage 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. Sanitary Sewer: To exterior force main.
- 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.

3.08 IDENTIFICATION

- A. Identify exposed sanitary waste and vent piping. Comply with requirements for identification specified in Section 22 05 53 "Identification for Plumbing Piping and Equipment."

3.09 FIELD QUALITY CONTROL

- 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 drainage 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. 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 drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping except outside leaders on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. 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. 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. Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. 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.
- E. Test force-main piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 2. Cap and subject piping to static-water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
 3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
 4. Prepare reports for tests and required corrective action.

3.10 CLEANING AND PROTECTION

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect 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. Exposed PVC Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint.

3.11 PIPING SCHEDULE

- A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.
- B. Aboveground, soil and waste piping NPS 6 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; CISPI heavy-duty hubless-piping couplings; and coupled joints.
 - 3. PVC pipe, PVC socket fittings, and solvent-cemented joints.
- C. Aboveground, vent piping NPS 6 and smaller shall be any of the following:
 - 1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 - 2. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
 - 3. Dissimilar Pipe-Material Couplings: Unshielded, nonpressure transition couplings.
- D. Underground, soil, waste, and vent piping NPS 6 and smaller shall be any of the following:
 - 1. Solid wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
 - 2. Dissimilar Pipe-Material Couplings: Unshielded, nonpressure transition couplings.

END OF SECTION 22 13 16

SECTION 22 13 19
SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00.
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) requirements.

1.03 SUMMARY

- A. Section Includes:
 - 1. Cleanouts.
 - 2. Floor drains.
 - 3. Roof flashing assemblies.
 - 4. Through-penetration firestop assemblies.
 - 5. Miscellaneous sanitary drainage piping specialties.
 - 6. Flashing materials.
- B. Related Requirements:
 - 1. Section 22 14 23 “Storm Drainage Piping Specialties” for storm drainage piping inside the building, drainage piping specialties, and drains.

1.04 DEFINITIONS

- A. FRP: Fiberglass-reinforced plastic.
- B. HDPE: High-density polyethylene plastic.
- C. PE: Polyethylene plastic.
- D. PVC: Polyvinyl chloride plastic.

1.05 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and accessories.

1.06 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For drainage piping specialties to include in emergency, operation, and maintenance manuals.

1.07 QUALITY ASSURANCE

- A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic sanitary piping specialty components.

1.08 COORDINATION

- A. Coordinate size and location of roof penetrations.

PART 2 - PRODUCTS

2.01 CLEANOUTS

- A. Cast-Iron Wall Cleanouts <WCO>:
 - 1. Standard: ASME A112.36.2M. Include wall access.
 - 2. Size: Same as connected drainage piping.
 - 3. Body: Hubless, cast-iron soil pipe test tee as required to match connected piping.
 - 4. Closure: Countersunk or raised-head, drilled-and-threaded brass plug.
 - 5. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
 - 6. Wall Access: Round, flat, chrome-plated brass or stainless-steel cover plate with screw.
 - 7. Wall Access: Round, nickel-bronze, copper-alloy, or stainless-steel wall-installation frame and cover.

2.02 FLOOR DRAINS

- A. Cast-Iron Floor Drains FD1:
 - 1. See schedule on drawing.

2.03 ROOF FLASHING ASSEMBLIES

- A. Roof Flashing Assemblies VTR:

1. Description: Manufactured assembly made of 6.0-lb/sq. ft., 0.0938-inch thick, lead flashing collar and skirt extending at least 10 inches from pipe, with galvanized-steel boot reinforcement and counterflashing fitting.
 - a. Open-Top Vent Cap: Without cap.

2.04 THROUGH-PENETRATION FIRESTOP ASSEMBLIES

A. Through-Penetration Firestop Assemblies:

1. Standard: UL 1479 assembly of sleeve and stack fitting with firestopping plug.
2. Size: Same as connected soil, waste, or vent stack.
3. 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.
4. 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.

2.05 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Floor-Drain, Trap-Seal Primer Fittings TP:

1. Description: Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
2. Size: Same as floor drain outlet with NPS 1/2 side inlet.

B. Sleeve Flashing Device:

1. Description: 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.
2. Size: As required for close fit to riser or stack piping.

C. Stack Flashing Fittings:

1. Description: Counterflashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.
2. Size: Same as connected stack vent or vent stack.

PART 3 - EXECUTION

3.01 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 cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
- C. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
1. Position floor drains for easy access and maintenance.
 2. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:
 - a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
 - b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
 - c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.
 3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
 4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.
- D. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof.
- E. Install flashing fittings on sanitary stack vents and vent stacks that extend through roof.
- F. Install through-penetration firestop assemblies in plastic conductors and stacks at floor penetrations.
- G. 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.
- H. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.
- 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.

3.02 CONNECTIONS

- A. Comply with requirements in Section 22 13 16 “Sanitary Waste and Vent Piping” for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment to allow service and maintenance.

3.03 FLASHING INSTALLATION

- A. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:
 - 1. Lead Sheets: Burn joints of lead sheets 6.0-lb/sq. ft., 0.0938-inch thickness or thicker. Solder joints of lead sheets 4.0-lb/sq. ft., 0.0625-inch thickness or thinner.
- B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.
 - 1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches, and skirt or flange extending at least 8 inches around pipe.
 - 2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
 - 3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.
- C. Set flashing on floors and roofs in solid coating of bituminous cement.
- D. Secure flashing into sleeve and specialty clamping ring or device.
- E. Install flashing for piping passing through roofs with counterflashing or commercially made flashing fittings, according to Section 07 62 00 “Sheet Metal Flashing and Trim.”
- F. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.
- G. Fabricate and install flashing and pans, sumps, and other drainage shapes.

3.04 PROTECTION

- A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 22 13 19

SECTION 22 14 13
FACILITY STORM DRAINAGE PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00.
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) requirements.

1.03 SUMMARY

- A. Section Includes:
 - 1. Pipe, tube, and fittings.
 - 2. Specialty pipe fittings.
- B. Related Sections:
 - 1. Section 33 41 00 “Storm Utility Drainage Piping” for storm drainage piping outside the building.

1.04 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:
 - 1. Storm Drainage Piping: 10-foot head of water.

1.05 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

1.06 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF/ANSI 14, “Plastics Piping System Components and Related Materials,” for plastic piping components. Include marking with “NSF-drain” for plastic drain piping and “NSF-sewer” for plastic sewer piping.

PART 2 - PRODUCTS

2.01 PIPING MATERIALS

- A. 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.

2.02 PVC PIPE AND FITTINGS

- A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.
- B. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.
- C. Adhesive Primer: ASTM F 656.
 - 1. Adhesive primer shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- D. Solvent Cement: ASTM D 2564.
 - 1. PVC solvent cement shall have a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

PART 3 - EXECUTION

3.01 EARTH MOVING

- A. Comply with requirements for excavating, trenching, and backfilling specified in Section 312000 “Earth Moving.”

3.02 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations from 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 storm drainage piping using appropriate branches, bends, and long-sweep bends. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
- K. Lay buried building storm drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.
- L. Install storm drainage piping at the following minimum slopes unless otherwise indicated:
 - 1. Building Storm Drain: 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 Storm-Drainage Piping: 2 percent downward in direction of flow.
- M. Install aboveground PVC piping according to ASTM D 2665.
- N. Install underground PVC piping according to ASTM D 2321.
- O. Plumbing Specialties:
 - 1. Install cleanouts at grade and extend to where building storm drains connect to building storm sewers in storm drainage gravity-flow piping. Install cleanout fitting with closure plug inside the building in storm drainage force-main piping. Comply with requirements for cleanouts specified in Section 22 14 23 "Storm Drainage Piping Specialties."
 - 2. Install drains in storm drainage gravity-flow piping. Comply with requirements for drains specified in Section 22 14 23 "Storm Drainage Piping Specialties."
- P. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
- Q. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 22 05 17 "Sleeves and Sleeve Seals for Plumbing Piping."
- R. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 22 05 17 "Sleeves and Sleeve Seals for Plumbing Piping."
- S. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 22 05 18 "Escutcheons for Plumbing Piping."

3.03 JOINT CONSTRUCTION

- A. Plastic, Nonpressure-Piping, Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
 - 1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
 - 2. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 Appendixes.

3.04 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements for pipe hanger and support devices and installation specified in Section 220529 “Hangers and Supports for Plumbing Piping and Equipment.”
 - 1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
 - 2. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
 - 3. Vertical Piping: MSS Type 8 or Type 42, clamps.
 - 4. 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.
 - 5. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 - 6. Base of Vertical Piping: MSS Type 52, spring hangers.
- B. Support horizontal piping and tubing within 12 inches of each fitting 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 PVC piping with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1-1/2 and NPS 2: 48 inches with 3/8-inch rod.
 - 2. NPS 3: 48 inches with 1/2-inch rod.
 - 3. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
 - 4. NPS 6 and NPS 8: 48 inches with 3/4-inch rod.
 - 5. NPS 10 and NPS 12: 48 inches with 7/8-inch rod.

- F. Install supports for vertical PVC piping every 48 inches.
- G. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.05 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect interior storm drainage piping to exterior storm drainage piping. Use transition fitting to join dissimilar piping materials.
- C. Connect storm drainage piping to roof drains and storm drainage specialties.
 - 1. Install test tees (wall cleanouts) in conductors near floor, and floor cleanouts with cover flush with floor.
 - 2. Comply with requirements for cleanouts and drains specified in Section 22 14 23 "Storm Drainage Piping Specialties."
- D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

3.06 IDENTIFICATION

- A. Identify exposed storm drainage piping. Comply with requirements for identification specified in Section 22 05 53 "Identification for Plumbing Piping and Equipment."

3.07 FIELD QUALITY CONTROL

- 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.
 - 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 storm drainage 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. 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 storm drainage piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
3. Test Procedure: Test storm drainage piping on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts until completion of inspection, water level must not drop. Inspect joints for leaks.
4. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
5. Prepare reports for tests and required corrective action.

3.08 CLEANING

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect 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.

3.09 PIPING SCHEDULE

- A. Aboveground storm drainage piping shall be the following:
 1. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
- B. Underground storm drainage piping shall be the following:
 1. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.

END OF SECTION 22 14 13

SECTION 22 14 23
STORM DRAINAGE PIPING SPECIALTIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00.
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) requirements.

1.03 SUMMARY

- A. Section Includes:
 - 1. Roof drains.
 - 2. Cleanouts.
 - 3. Through-penetration firestop assemblies.
 - 4. Flashing materials.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

1.05 QUALITY ASSURANCE

- A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

PART 2 - PRODUCTS

2.01 METAL ROOF DRAINS

- A. Cast-Iron, Medium-Sump, Combination/Overflow Roof Drains: RD:
 - 1. See schedule on drawings.
- B. Overflow Drains: OD1
 - 1. See schedule on drawings.

2.02 CLEANOUTS

- A. Test Tees:

1. Standard: ASME A112.36.2M and ASTM A 74, ASTM A 888, or CISPI 301, for cleanout test tees.
2. Size: Same as connected drainage piping.
3. Body Material: Hub-and-spigot, cast-iron soil-pipe T-branch or hubless, cast-iron soil-pipe test tee as required to match connected piping.
4. Closure Plug: Countersunk or raised head, brass.
5. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

B. Wall Cleanouts WCO:

1. Standard: ASME A112.36.2M, for cleanouts. Include wall access.
2. Size: Same as connected drainage piping.
3. Body Material: Hubless, cast-iron soil-pipe test tee as required to match connected piping.
4. Closure: Countersunk or raised-head, drilled-and-threaded brass plug.
5. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
6. Wall Access: Round, flat, chrome-plated brass cover plate with screw.
7. Wall Access: Round, nickel-bronze, copper-alloy, or stainless-steel wall-installation frame and cover.

2.03 THROUGH-PENETRATION FIRESTOP ASSEMBLIES

A. Through-Penetration Firestop Assemblies:

1. Standard: ASTM E 814, for through-penetration firestop assemblies.
2. Certification and Listing: Intertek Testing Service NA acceptable to authorities having jurisdiction for through-penetration firestop assemblies.
3. Size: Same as connected pipe.
4. 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.
5. 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.

2.04 FLASHING MATERIALS

- A. Copper Sheet: ASTM B 152/B 152M, 12 oz./sq. ft..
- B. Zinc-Coated Steel Sheet: ASTM A 653/A 653M, with 0.20 percent copper content and 0.04-inch minimum thickness unless otherwise indicated. Include G90 hot-dip galvanized, mill-phosphatized finish for painting if indicated.

- C. Elastic Membrane Sheet: ASTM D 4068, flexible, chlorinated polyethylene, 40-mil minimum thickness.
- D. Fasteners: Metal compatible with material and substrate being fastened.
- E. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.
- F. Solder: ASTM B 32, lead-free alloy.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install roof drains at low points of roof areas according to roof membrane manufacturer's written installation instructions.
 - 1. Install flashing collar or flange of roof drain to prevent leakage between drain and adjoining roofing. Maintain integrity of waterproof membranes where penetrated.
 - 2. Install expansion joints, if indicated, in roof drain outlets.
 - 3. Position roof drains for easy access and maintenance.
- B. Install cleanouts in aboveground piping and building drain piping according to the following instructions unless otherwise indicated:
 - 1. Use cleanouts the same size as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
 - 2. Locate cleanouts at each change in direction of piping greater than 45 degrees.
 - 3. Locate cleanouts at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
 - 4. Locate cleanouts at base of each vertical soil and waste stack.
- 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 test tees in vertical conductors and near floor.
- E. Install wall cleanouts in vertical conductors. Install access door in wall.
- F. Install through-penetration firestop assemblies in plastic conductors at concrete floor penetrations.
- G. Install sleeve flashing device with each conductor passing through floors with waterproof membrane.

3.02 CONNECTIONS

- A. Comply with requirements for piping specified in Section 22 14 13 “Facility Storm Drainage Piping.” Drawings indicate general arrangement of piping, fittings, and specialties.

3.03 FLASHING INSTALLATION

- A. Fabricate flashing from single piece of metal unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:
 - 1. Lead Sheets: Burn joints of 6.0-lb/sq. ft. lead sheets, 0.0938-inch thickness or thicker. Solder joints of 4.0-lb/sq. ft. lead sheets, 0.0625-inch thickness or thinner.
 - 2. Copper Sheets: Solder joints of copper sheets.
- B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.
 - 1. Pipe Flashing: Sleeve type, matching the pipe size, with a minimum length of 10 inches and with skirt or flange extending at least 8 inches around pipe.
 - 2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
 - 3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.
- C. Set flashing on roofs in solid coating of bituminous cement.
- D. Secure flashing into sleeve and specialty clamping ring or device.
- E. Fabricate and install flashing and pans, sumps, and other drainage shapes.

3.04 PROTECTION

- A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 22 14 23

SECTION 22 33 00
ELECTRIC, DOMESTIC-WATER HEATERS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00.
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) requirements.

1.03 SUMMARY

- A. Section Includes:
 - 1. Commercial, light-duty, storage, electric, domestic-water heaters.
 - 2. Domestic-water heater accessories.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type and size of domestic-water heater indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings:
 - 1. Wiring Diagrams: For power, signal, and control wiring.

1.05 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of electric, domestic-water heater, from manufacturer.
- B. Warranty: Sample of special warranty.

1.06 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For electric, domestic-water heaters to include in emergency, operation, and maintenance manuals.

1.07 QUALITY ASSURANCE

- A. 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.
- B. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.

- C. ASME Compliance: Where ASME-code construction is indicated, fabricate and label commercial, domestic-water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
- D. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61 Annex G, "Drinking Water System Components - Health Effects."

1.08 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.09 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of electric, domestic-water heaters that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures including storage tank and supports.
 - b. Faulty operation of controls.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal use.
 - 2. Warranty Periods: From date of Substantial Completion.
 - a. Commercial, Light-Duty, Storage, Electric, Domestic-Water Heaters:
 - 1) Storage Tank: Three years.
 - 2) Controls and Other Components: Two years.
 - b. Compression Tanks: Five years.

PART 2 - PRODUCTS

2.01 COMMERCIAL, ELECTRIC, DOMESTIC-WATER HEATERS

- A. Commercial, Light-Duty, Storage, Electric, Domestic-Water Heaters:
 - 1. See schedule on drawings.

2.02 DOMESTIC-WATER HEATER ACCESSORIES

- A. Domestic-Water Compression Tanks:
 - 1. Description: Steel pressure-rated tank constructed with welded joints and factory-installed butyl-rubber diaphragm. Include air precharge to minimum system-operating pressure at tank.
 - 2. Construction:

- a. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1 pipe thread.
 - 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. Air-Charging Valve: Factory installed.
3. Capacity and Characteristics:
- a. Working-Pressure Rating: 100 psig.
 - b. Capacity Acceptable: 4 gal. minimum.
 - c. Air Precharge Pressure: 40 psig.
- B. Drain Pans: Corrosion-resistant metal with raised edge. Comply with ANSI/CSA LC 3. Include dimensions not less than base of domestic-water heater, and include drain outlet not less than NPS 3/4 with ASME B1.20.1 pipe threads or with ASME B1.20.7 garden-hose threads.
- C. Piping-Type Heat Traps: Field-fabricated piping arrangement according to ASHRAE/IESNA 90.1 or ASHRAE 90.2.
- D. Combination Temperature-and-Pressure Relief Valves: ASME rated and stamped. 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.
- E. Pressure Relief Valves: ASME rated and stamped. Include pressure setting less than domestic-water heater working-pressure rating.
- F. Vacuum Relief Valves: ANSI Z21.22/CSA 4.4.
- G. Domestic-Water Heater Mounting Brackets: Manufacturer's factory-fabricated steel bracket for wall mounting, capable of supporting domestic-water heater and water.

2.03 SOURCE QUALITY CONTROL

- A. Factory Tests: Test and inspect domestic-water heaters specified to be ASME-code construction, according to ASME Boiler and Pressure Vessel Code.
- B. Hydrostatically test commercial domestic-water heaters to minimum of one and one-half times pressure rating before shipment.
- C. Electric, domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Section 01 40 00 "Quality Requirements" for retesting and reinspecting requirements and Section 01 73 00 "Execution" for requirements for correcting the Work.
- D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.01 DOMESTIC-WATER HEATER INSTALLATION

- A. Commercial, Electric, Domestic-Water Heater Mounting: Install commercial, electric, domestic-water heaters on wall brackets.
 - 1. Maintain manufacturer's recommended clearances.
 - 2. Arrange units so controls and devices that require servicing are accessible.
 - 3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 4. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 5. Anchor domestic-water heaters to substrate.
- B. Install electric, domestic-water heaters level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.
 - 1. Install shutoff valves on domestic-water-supply piping to domestic-water heaters and on domestic-hot-water outlet piping. Comply with requirements for shutoff valves specified in Section 22 05 23.12 "Ball Valves for Plumbing Piping," and Section 22 05 23.15 "Gate Valves for Plumbing Piping."
- C. Install combination temperature-and-pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.
- D. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for electric, domestic-water heaters that do not have tank drains. Comply with requirements for hose-end drain valves specified in Section 22 11 19 "Domestic Water Piping Specialties."
- E. Install thermometers on outlet piping of electric, domestic-water heaters. Comply with requirements for thermometers specified in Section 22 05 19 "Meters and Gages for Plumbing Piping."
- F. Install piping-type heat traps on inlet and outlet piping of electric, domestic-water heater storage tanks without integral or fitting-type heat traps.
- G. Fill electric, domestic-water heaters with water.
- H. Charge domestic-water compression tanks with air.

3.02 CONNECTIONS

- A. Comply with requirements for piping specified in Section 22 11 16 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

- B. Where installing piping adjacent to electric, domestic-water heaters, allow space for service and maintenance of water heaters. Arrange piping for easy removal of domestic-water heaters.

3.03 IDENTIFICATION

- A. Identify system components. Comply with requirements for identification specified in Section 22 05 53 “Identification for Plumbing Piping and Equipment.”

3.04 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
 - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.
 - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Electric, domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Section 01 40 00 “Quality Requirements” for retesting and reinspecting requirements and Section 01 73 00 “Execution” for requirements for correcting the Work.
- C. Prepare test and inspection reports.

3.05 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain commercial, electric, domestic-water heaters.

END OF SECTION 22 33 00

SECTION 22 42 13.13
COMMERCIAL WATER CLOSETS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00.
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) requirements.

1.03 SUMMARY

- A. Section Includes:
 - 1. Water closets.
 - 2. Flushometer valves.
 - 3. Toilet seats.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for water closets.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: Include diagrams for power, signal, and control wiring.

1.05 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For flushometer valves and electronic sensors to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.01 WALL-MOUNTED, BACK OUTLET WATER CLOSETS

- A. Water Closets P1: Wall mounted, back outlet, top spud, Handicapped.
 - 1. See schedule on drawings.
- B. Water Closets P2: Wall mounted, back outlet, top spud.

1. See schedule on drawings.

2.02 FLUSHOMETER VALVES

A. See schedule on drawings.

2.03 TOILET SEATS

A. See schedule on drawings.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before water-closet installation.
- B. Examine walls and floors for suitable conditions where water closets will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Water-Closet Installation:

- 1. Install level and plumb according to roughing-in drawings.
- 2. Install accessible, wall-mounted water closets at mounting height indicated in schedule on drawings.

B. Support Installation:

- 1. Use carrier supports with waste-fitting assembly and seal.
- 2. Install wall-mounted, back-outlet water-closet supports with waste-fitting assembly and waste-fitting seals; and affix to building substrate.

C. Flushometer-Valve Installation:

- 1. Install flushometer-valve, water-supply fitting on each supply to each water closet.
- 2. Attach supply piping to supports or substrate within pipe spaces behind fixtures.
- 3. Install lever-handle flushometer valves for accessible water closets with handle mounted on open side of water closet.
- 4. Install actuators in locations that are easy for people with disabilities to reach.

D. Install toilet seats on water closets.

E. Wall Flange and Escutcheon Installation:

- 1. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations and within cabinets and millwork.

2. Install deep-pattern escutcheons if required to conceal protruding fittings.
 3. Comply with escutcheon requirements specified in Section 220518 “Escutcheons for Plumbing Piping.”
- F. Joint Sealing:
1. Seal joints between water closets and walls and floors using sanitary-type, one-part, mildew-resistant silicone sealant.
 2. Match sealant color to water-closet color.
 3. Comply with sealant requirements specified in Section 079200 “Joint Sealants.”

3.03 CONNECTIONS

- A. Connect water closets with water supplies and soil, waste, and vent piping. Use size fittings required to match water closets.
- B. Comply with water piping requirements specified in Section 221116 “Domestic Water Piping.”
- C. Comply with soil and waste piping requirements specified in Section 221316 “Sanitary Waste and Vent Piping.”
- D. Where installing piping adjacent to water closets, allow space for service and maintenance.

3.04 ADJUSTING

- A. Operate and adjust water closets and controls. Replace damaged and malfunctioning water closets, fittings, and controls.
- B. Adjust water pressure at flushometer valves to produce proper flow.

3.05 CLEANING AND PROTECTION

- A. Clean water closets and fittings with manufacturers' recommended cleaning methods and materials.
- B. Install protective covering for installed water closets and fittings.
- C. Do not allow use of water closets for temporary facilities unless approved in writing by Owner.

END OF SECTION 22 42 13.13

SECTION 22 42 13.16
COMMERCIAL URINALS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00.
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) requirements.

1.03 SUMMARY

- A. Section Includes:
 - 1. Urinals.
 - 2. Flushometer valves.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for urinals.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

1.05 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For flushometer valves and electronic sensors to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.01 URINALS

- A. Urinals P3 and P4.
 - 1. See schedule on drawings.

2.02 URINAL FLUSHOMETER VALVES

- A. See schedule on drawing.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before urinal installation.
- B. Examine walls and floors for suitable conditions where urinals will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Urinal Installation:

- 1. Install urinals level and plumb according to roughing-in drawings.
- 2. Install wall-hung, back-outlet urinals onto waste fitting seals and attached to supports.
- 3. Install wall-hung, bottom-outlet urinals with tubular waste piping attached to supports.
- 4. Install accessible, wall-mounted urinals at mounting height for the handicapped/elderly, according to ICC/ANSI A117.1.

B. Support Installation:

- 1. Install supports, affixed to building substrate, for wall-hung urinals.
- 2. Use off-floor carriers with waste fitting and seal for back-outlet urinals.
- 3. Use carriers without waste fitting for urinals with tubular waste piping.
- 4. Use chair-type carrier supports with rectangular steel uprights for accessible urinals.

C. Flushometer-Valve Installation:

- 1. Install flushometer-valve water-supply fitting on each supply to each urinal.
- 2. Attach supply piping to supports or substrate within pipe spaces behind fixtures.
- 3. Install lever-handle flushometer valves for accessible urinals with handle mounted on open side of compartment.

D. Wall Flange and Escutcheon Installation:

- 1. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations.
- 2. Install deep-pattern escutcheons if required to conceal protruding fittings.
- 3. Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping."

- E. Joint Sealing:
 - 1. Seal joints between urinals and walls and floors using sanitary-type, one-part, mildew-resistant silicone sealant.
 - 2. Match sealant color to urinal color.
 - 3. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

3.03 CONNECTIONS

- A. Connect urinals with water supplies and soil, waste, and vent piping. Use size fittings required to match urinals.
- B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."
- C. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."
- D. Where installing piping adjacent to urinals, allow space for service and maintenance.

3.04 ADJUSTING

- A. Operate and adjust urinals and controls. Replace damaged and malfunctioning urinals, fittings, and controls.
- B. Adjust water pressure at flushometer valves to produce proper flow.

3.05 CLEANING AND PROTECTION

- A. Clean urinals and fittings with manufacturers' recommended cleaning methods and materials.
- B. Install protective covering for installed urinals and fittings.
- C. Do not allow use of urinals for temporary facilities unless approved in writing by Owner.

END OF SECTION 22 42 13.16

SECTION 22 42 16.13
COMMERCIAL LAVATORIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00.
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) requirements.

1.03 SUMMARY

- A. Section Includes:
 - 1. Lavatories.
 - 2. Faucets.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for lavatories.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: Include diagrams for power, signal, and control wiring of automatic faucets.

1.05 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For lavatories and faucets to include in operation and maintenance manuals.
 - 1. In addition to items specified in Section 01 78 23 “Operation and Maintenance Data,” include the following:
 - a. Servicing and adjustments of automatic faucets.

PART 2 - PRODUCTS

2.01 LAVATORIES

- A. Lavatory P5 and P6. See schedule on drawings.

2.02 SOLID-BRASS, AUTOMATICALLY OPERATED LAVATORY 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. See schedule on drawings.

2.03 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.
- B. See schedule on drawings.

2.04 WASTE FITTINGS

- A. See schedule on drawings.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before lavatory installation.
- B. Examine counters and walls for suitable conditions where lavatories will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Install lavatories level and plumb according to roughing-in drawings.
- B. Install supports, affixed to building substrate, for wall-mounted lavatories.
- C. Install accessible wall-mounted lavatories at handicapped/elderly mounting height for people with disabilities or the elderly, according to ICC/ANSI A117.1.
- D. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 22 05 18 “Escutcheons for Plumbing Piping.”
- E. Seal joints between lavatories, counters, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 07 92 00 “Joint Sealants.”
- F. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible lavatories. Comply with requirements in Section 22 07 19 “Plumbing Piping Insulation.”

3.03 CONNECTIONS

- A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- B. Comply with water piping requirements specified in Section 22 11 16 “Domestic Water Piping.”
- C. Comply with soil and waste piping requirements specified in Section 22 13 16 “Sanitary Waste and Vent Piping.”

3.04 ADJUSTING

- A. Operate and adjust lavatories and controls. Replace damaged and malfunctioning lavatories, fittings, and controls.
- B. Adjust water pressure at faucets to produce proper flow.
- C. Install fresh batteries in battery-powered, electronic-sensor mechanisms.

3.05 CLEANING AND PROTECTION

- A. After completing installation of lavatories, inspect and repair damaged finishes.
- B. Clean lavatories, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.
- C. Provide protective covering for installed lavatories and fittings.
- D. Do not allow use of lavatories for temporary facilities unless approved in writing by Owner.

END OF SECTION 22 42 16.13

SECTION 22 42 16.16
COMMERCIAL SINKS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00.
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) requirements.

1.03 SUMMARY

- A. Section Includes:
 - 1. Service sinks.
 - 2. Sinks.
 - 3. Sink faucets.
 - 4. Supply fittings.
 - 5. Waste fittings.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for sinks.
 - 2. Include rated capacities, operating characteristics and furnished specialties and accessories.

1.05 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Counter cutout templates for mounting of counter-mounted lavatories.

1.06 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For sinks to include in maintenance manuals.

PART 2 - PRODUCTS

2.01 SERVICE SINKS

- A. Service Sinks P10.
 - 1. See schedule on drawings.

2.02 SINKS

- A. Sinks P9
 - 1. See schedule on drawing.

2.03 SINK FAUCETS

- A. NSF Standard: Comply with NSF/ANSI 61 Annex G, "Drinking Water System Components - Health Effects," for faucet-spout materials that will be in contact with potable water.
- B. Sink Faucets See schedule on drawings.

2.04 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.
- B. See schedule on drawings.

2.05 WASTE FITTINGS

- A. See schedule on drawings.

2.06 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.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before sink installation.
- B. Examine walls, floors, and counters for suitable conditions where sinks will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Install sinks level and plumb according to roughing-in drawings.
- B. Install supports, affixed to building substrate, for wall-hung sinks.
- C. Install accessible wall-mounted sinks at handicapped/elderly mounting height according to ICC/ANSI A117.1.
- D. Set floor-mounted sinks in leveling bed of cement grout.
- E. Install water-supply piping with stop on each supply to each sink faucet.
 - 1. Exception: Use ball or gate valves if supply stops are not specified with sink. Comply with valve requirements specified in Section 22 05 23.12 “Ball Valves for Plumbing Piping” and Section 22 05 23.15 “Gate Valves for Plumbing Piping.”
 - 2. Install stops in locations where they can be easily reached for operation.
- F. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 22 05 18 “Escutcheons for Plumbing Piping.”
- G. Seal joints between sinks and counters, floors, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 07 92 00 “Joint Sealants.”
- H. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible sinks. Comply with requirements in Section 22 07 19 “Plumbing Piping Insulation.”

3.03 CONNECTIONS

- A. Connect sinks with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- B. Comply with water piping requirements specified in Section 22 11 16 “Domestic Water Piping.”
- C. Comply with soil and waste piping requirements specified in Section 22 13 16 “Sanitary Waste and Vent Piping.”

3.04 ADJUSTING

- A. Operate and adjust sinks and controls. Replace damaged and malfunctioning sinks, fittings, and controls.
- B. Adjust water pressure at faucets to produce proper flow.

3.05 CLEANING AND PROTECTION

- A. After completing installation of sinks, inspect and repair damaged finishes.

- B. Clean sinks, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.
- C. Provide protective covering for installed sinks and fittings.
- D. Do not allow use of sinks for temporary facilities unless approved in writing by Owner.

END OF SECTION 22 42 16.16

SECTION 22 42 23
COMMERCIAL SHOWERS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00.
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) requirements.

1.03 SUMMARY

- A. Section Includes:
 - 1. Individual shower receptors.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for showers.
 - 2. Include rated capacities, operating characteristics, and furnished specialties and accessories.

1.05 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For shower faucets to include in maintenance manuals.

PART 2 - PRODUCTS

2.01 SHOWER FAUCETS

- A. NSF Standard: Comply with NSF 61 Annex G, “Drinking Water System Components - Health Effects,” for shower materials that will be in contact with potable water.
- B. See schedule on drawings.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine roughing-in of water-supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before shower installation.

- B. Examine walls and floors for suitable conditions where showers will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Assemble shower components according to manufacturers' written instructions.
- B. Install showers level and plumb according to roughing-in drawings.
- C. Install water-supply piping with stop on each supply to each shower faucet.
 - 1. Exception: Use ball or gate valves if supply stops are not specified with shower. Comply with valve requirements specified in Section 22 05 23.12 "Ball Valves for Plumbing Piping" and Section 22 05 23.15 "Gate Valves for Plumbing Piping."
 - 2. Install stops in locations where they can be easily reached for operation.
- D. Install shower flow-control fittings with specified maximum flow rates in shower arms.
- E. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheons requirements specified in Section 22 05 18 "Escutcheons for Plumbing Piping."
- F. Seal joints between showers and floors and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 07 92 00 "Joint Sealants."

3.03 CONNECTIONS

- A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- B. Comply with water piping requirements specified in Section 22 11 16 "Domestic Water Piping."
- C. Comply with traps and soil and waste piping requirements specified in Section 22 13 16 "Sanitary Waste and Vent Piping."

3.04 ADJUSTING

- A. Operate and adjust showers and controls. Replace damaged and malfunctioning showers, fittings, and controls.
- B. Adjust water pressure at faucets to produce proper flow.

3.05 CLEANING AND PROTECTION

- A. After completing installation of showers, inspect and repair damaged finishes.
- B. Clean showers, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.

- C. Provide protective covering for installed fixtures and fittings.
- D. Do not allow use of showers for temporary facilities unless approved in writing by Owner.

END OF SECTION 22 42 23

SECTION 22 47 16
PRESSURE WATER COOLERS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00.
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) requirements.

1.03 SUMMARY

- A. Section includes pressure water coolers and related components.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of pressure water cooler.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: Include diagrams for power, signal, and control wiring.

1.05 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For pressure water coolers to include in maintenance manuals.

PART 2 - PRODUCTS

2.01 ELECTRIC WATER COOLERS

- A. Electric Water Coolers.
 - 1. See schedule on drawings.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine roughing-in for water-supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before fixture installation.
- B. Examine walls and floors for suitable conditions where fixtures will be installed.

- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Install fixtures level and plumb according to roughing-in drawings. For fixtures indicated for children, install at height required by authorities having jurisdiction.
- B. Install off-the-floor carrier supports, affixed to building substrate, for wall-mounted fixtures.
- C. Install mounting frames, affixed to building construction, and attach recessed, pressure water coolers to mounting frames.
- D. Install water-supply piping with shutoff valve on supply to each fixture to be connected to domestic-water distribution piping. Use ball or gate valve. Install valves in locations where they can be easily reached for operation. Valves are specified in Section 22 05 23.12 “Ball Valves for Plumbing Piping” and Section 22 05 23.15 “Gate Valves for Plumbing Piping.”
- E. Install trap and waste piping on drain outlet of each fixture to be connected to sanitary drainage system.
- F. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons where required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 22 05 18 “Escutcheons for Plumbing Piping.”
- G. Seal joints between fixtures and walls using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 07 92 00 “Joint Sealants.”

3.03 CONNECTIONS

- A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- B. Comply with water piping requirements specified in Section 22 11 16 “Domestic Water Piping.”
- C. Install ball or gate shutoff valve on water supply to each fixture. Install valve upstream from filter for water cooler. Comply with valve requirements specified in Section 22 05 23.12 “Ball Valves for Plumbing Piping” and Section 22 05 23.15 “Gate Valves for Plumbing Piping.”
- D. Comply with soil and waste piping requirements specified in Section 22 13 16 “Sanitary Waste and Vent Piping.”

3.04 ADJUSTING

- A. Adjust fixture flow regulators for proper flow and stream height.
- B. Adjust pressure water-cooler temperature settings.

3.05 CLEANING

- A. After installing fixture, inspect unit. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.
- B. Clean fixtures, on completion of installation, according to manufacturer's written instructions.
- C. Provide protective covering for installed fixtures.
- D. Do not allow use of fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 22 47 16

SECTION 23 00 00
MECHANICAL REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Work herein shall conform to all applicable laws, ordinances, and to regulations of the local utility companies. The general conditions and all requirements of the contract documents shall apply to all work of this section. Work shall be in accordance with the requirements of:
 - 1. Florida Building Code (FBC) 8th Edition (2023): This code includes the 2023 FBC Building, Mechanical, Plumbing, Energy Conservation, Fuel Gas, Accessibility, and Test Protocols volumes. Further, see "Referenced Standards" in the FBC Building Chapter 35; FBC Mechanical Chapter 15; FBC Plumbing Chapter 15; FBC Energy Conservation Chapter 6; and FBC Fuel Gas Chapter 8) (Effective December 31, 2023).
 - 2. 8th Edition of the Florida Fire Prevention Code (FFPC): This code also includes the Florida versions of NFPA 1 and NFPA 101. (Effective December 31, 2023).
 - 3. 2020 National Electric Code.
- B. Cooperate with all other trades and install work as fast as the progress of the job will permit.
- C. Use only mechanics skilled in the work they are to perform and have a competent representative on the job when any work is being done.
- D. No work shall be done unless the Superintendent of the Contractor is on the job site. Work shall be properly protected, all rubbish removed promptly, and exposed work shall be carefully cleaned prior to final acceptance.
- E. The term "provide" shall include labor, materials, and equipment necessary to furnish and install, complete and operable, the item or system indicated.
- F. In decisions arising from discrepancies, interpretation of Drawings and Specifications, substitutes, and other pertinent matters, the decision of the Owner's representative's approval shall be final.

1.2 SPECIFICATIONS AND DRAWINGS

- A. Plans show location of fixtures and equipment and are intended to depict the general intent of the work in scope, layout and quality of workmanship. They are not intended to show in minute detail every or all accessories intended for the purpose of executing the work, but it is understood that such details are a part of this work.
- B. Where Drawings and Specifications conflict, it shall be the responsibility of this Contractor to bring such conflict to the attention of the Architect/Engineer for clarification. Refer to Supplementary Conditions, Paragraph 1.2. In general, the Architectural Drawings shall take precedence over the Mechanical Drawings with reference to building construction. All changes from the Drawings necessary to make the work conform with the building as

constructed and to fit the work of other trades or to conform to the rules of authorities having jurisdiction, shall be made by the Contractor at his own expense.

- C. Keep a record of the locations of concealed work and of any field changes in Contract Drawings and Specifications for each trade and, upon completion of the job. Refer to Specification Section 017000, "Closeout" for requirements.

1.3 PERMITS, FEES AND INSPECTIONS:

- A. The Contractor shall give all necessary notices, obtain all permits and pay all government fees in accordance with the Supplementary Conditions, sales taxes and other costs, including utility connections or extensions, in connection with this work; file all permit applications required by all governmental departments having jurisdiction.
- B. Obtain all required certificates of inspection for work and deliver them to the Owner before requesting acceptance and final payment for the work.
- C. The Contractor shall include in the work, without extra cost to the Owner, any labor, materials, services, apparatus and drawings required to comply with all applicable laws, ordinances, rules and regulations.
- D. The Contractor shall inform the Owner of any work or materials which conflict with any of the applicable codes, standards, laws and regulations before submitting his bid.

1.4 GENERAL

- A. Materials or products specified herein and/or indicated on drawings by trade name, manufacturer's name and/or catalog number shall be provided as specified. Substitutions will not be permitted except as described herein and in the Supplementary and General Conditions.
- B. Since manufacturers reserve the right to change their products at any time, contractors shall verify all dimensions, performance data, etc. for each piece of equipment submitted to assure compliance with the intent of the drawings and specifications.
- C. All materials shall be new and of quality as specified, and when required, be clearly labeled and/or stamped as manufactured in the United States.
- D. Where an accepted substitution or deviation requires different quantity or arrangement of foundations, supports, ductwork, piping, wiring, conduit, and any other equipment or accessories normal to this equipment, contractor shall furnish said changes and additions and pay all costs for all changes and additions to his work and the work of others affected by this substitution or deviation.
- E. Deviations mean the use of any listed approved manufacturer other than those on which the drawings are based.

1.5 SHOP AND ERECTION DRAWINGS AND SAMPLES

- A. The Architect/Engineer's approval shall be obtained for all equipment and material before delivery to the job site. Delivery, storage or installation of equipment or material which has not had prior approval will not be permitted at the job site. Submittals shall be made for all equipment and systems as indicated in the respective specification section.

- B. All submittals shall include adequate descriptive literature, catalog cuts, shop drawings and other data necessary for the Architect/Engineer to ascertain that the proposed equipment and materials comply with specification and drawing requirements. Catalog cuts submitted for approval shall be legible and clearly identify equipment being submitted.
- C. Shop and erection drawing submittals shall conform to the requirements of the General Conditions and Division 00 specifications except as modified herein.
- D. Submit required and/or requested shop and erection drawings, for review by Architect/Engineer before ordering or installing any equipment or material. Equipment or material ordered or installed before Architect/Engineer review may not be accepted and may have to be removed from the project if deemed unacceptable.
- E. Shop drawings shall consist of manufacturer's scale drawings, cuts or catalogs, including descriptive literature which shall clearly indicate the construction, material, physical dimensions, wiring diagrams and complete operating data clearly marked for each item. Data of general nature will not be accepted.
- F. Shop drawings on paper larger than 11"x17" shall be submitted in the form of one set of reproducibles (vellum) and one set of blueprints. The blueprints will be retained by the engineer and the reproducibles will be returned to the contractor.
 - 1. Coordination drawings shall show major elements, components, and systems of mechanical equipment and materials in relationship with other building components. Prepare drawings to an accurate scale of 1/4"=1'-0" or larger. Indicate the locations of all equipment and materials, including clearances for installing, servicing and maintaining equipment, valve stem movement, and similar requirements. Indicate movement and positioning of large equipment into the building during construction.
- G. Submittals for individual systems and equipment assemblies which consist of more than one item or component shall be made for the system or assembly as a whole. Partial submittals will not be considered for approval. Submittals shall be submitted for all applicable products and materials specified in each individual section of these specifications.
- H. Make submittals for the equipment and materials in accordance with the following:
 - 1. Mark the submittals, "SUBMITTED UNDER SECTION_____".
 - 2. Submittals shall be marked to show specification reference including the section and paragraph numbers.
 - 3. The submittals shall include the following:
 - a. Information that confirms compliance with contract requirements. Include the manufacturer's name, model or catalog numbers, catalog information, technical data sheets, shop drawings, pictures, nameplate data and test reports as required. Provide any additional information specifically requested in the individual specification section or on the drawings.
 - b. Parts list which shall include those replacement parts recommended by the equipment manufacturer, quantity of parts, current price and availability of each part.

4. Electronic PDF submittal files shall be named utilizing the specification number followed by a sequential number for the submittal made under the given specification number followed by “r#” if it is a resubmittal, and then followed by a brief description of the submitted item.
 - a. The description shall indicate the actual item submitted, shall not be general in nature, and does not have to be that of the specification section heading.
 - b. Using the example, “23 05 19-4r2 Differential Pressure Gauge”; 23 05 19 – Meters and Gauges is the relevant specification, the “4” shows it was the fourth submittal for specification section 23 05 19 02, “r2” shows it was the second resubmittal, and the description indicates what item is submitted.
 - c. Each specification item shall be submitted in a separate PDF file. PDF files with multiple specification items will be returned without review.
 - d. Each file shall have sufficient space allowance for the Architects and Engineer’s review stamp(s).
 - e. Each file shall have the Construction Manager’s review stamp(s) and indicate information required by specification 23 00 00.1.5.K.
- I. Shop drawings on paper 11”X17” or smaller in size shall be submitted in a tabbed and indexed three ring binder. The binder shall not exceed 11-5/8” height. Partial submittals are unacceptable. The index shall indicate the related specification section number.
- J. A fee will be charged for Engineering review plans that have been rejected two or more times due to non-compliance or incompleteness. The fee will be determined by the Architect/Engineer and the CM will back charge the responsible subcontractor and will reimburse the Owner by change order for the additional fees.
- K. The Construction manager will certify that all Division 23 shop drawings are in conformance with the plans and specifications. Deviations from the plans and specifications shall be noted, and the specific area of the deviation clouded and in contrasting color (green) with a complete explanation for the reasons for the deviation. Any redesign of the system shall be Certified by a Professional Engineer currently registered in the State of Florida, and will be accompanied by the fees as described in “J” above.
- L. Carefully examine all shop drawings and mark-up as necessary before submitting to the Architect/Engineer for review. The consultant will only consider shop drawings bearing the contractor’s stamp of approval.
- M. The engineer’s review shall not relieve the contractor from the responsibility for deviations from drawings and specifications. The engineer’s review shall be construed to apply only to general arrangement and shall not relieve the contractor from the responsibility for the correctness of details and dimensions and provision of the correct equipment.
- N. The contractor shall retain copies of all reviewed shop drawings on the job site for reference.
- O. In addition to the requirement of SUBMITTALS, the Owner reserves the right to request the manufacturer to arrange for the Owner’s representative(s) to see typical active systems in operation, when there has been no prior experience with the manufacturer or the type of equipment being submitted.
- P. Operation and Maintenance Manuals:

1. Maintenance manuals shall be complete and shall be furnished in a loose leaf binder or in the manufacturer's standard binder. Information shall be sufficient to enable a qualified technician to perform normal first line maintenance and repair. A parts list shall be included which shall include those replacement parts recommended by the equipment manufacturer, quantity of parts, current price and availability of each part.
2. Operation manuals shall be clear and concise and shall describe, in detail, the information required to properly operate the equipment specified. The manuals shall include complete catalog cuts and as-built wiring diagrams.
3. Operation and maintenance manuals shall be submitted for approval prior to final close-out.

1.6 EXPERIENCE

- A. The Contractor performing this work shall be a licensed, reputable firm, regularly performing the type of work incorporated in this project and who also maintains, as part of the firm, a service department with qualified personnel who regularly perform this type of work. The Contractor shall, upon request, show evidence of at least two jobs of similar character and size installed within the preceding two years.

1.7 COORDINATION WITH OTHER TRADES

- A. Contractor shall coordinate his work with other trades to avoid interferences and delays. He shall assist in working out space requirements to make a satisfactory installation.
- B. If the Contractor installs his work before coordinating with other trades, or so as to cause any interference with the work of other trades, he shall make the necessary changes in his work to correct the condition without extra charge.
- C. The Contractor shall furnish to other trades, as required, all necessary templates, patterns, setting plans, and shop details for the proper installation of work and for the purpose of coordinating adjacent work.

1.8 STORAGE OF MATERIALS

- A. All materials stored on site shall be properly protected from injury or deterioration. Materials shall not be stored in contact with ground or floor.
- B. Do not remove manufacturer's packing materials until ready to install. Materials showing signs of corrosion, improper handling or storage shall be replaced at no cost to the Owner.
- C. Provide continuous protection for all equipment already installed.

1.9 CUTTING, PATCHING, EXCAVATION, BACKFILL, AND LAYOUT

- A. Provide openings and excavation required for the installation of the work. Patch work and backfill as required. Finished work shall match the existing adjoining work.
- B. Verify all conditions affecting the work to be performed under this contract.
- C. Carefully verify measurements at the site, determine the exact location of chases and openings required. Provide sleeves, inserts, and hangers as required. No columns, beams,

joists, building foundations or any other structural building component shall be cut, drilled or disturbed in any way. Conflicts shall immediately be brought to the attention of the Architect/Engineer.

- D. All excavation on sites containing existing buildings and existing services shall be done with hand shovel to avoid damage to existing services. Any damage incurred by the Contractor shall be repaired by the Contractor in a manner approved by the Architect/Engineer at no cost to the Owner and with no extension of time limitation.

1.10 REMOVAL OF RUBBISH

- A. Contractor shall keep premises free from accumulations of waste material or rubbish caused by his employees or work in accordance with Division 00 - Construction Procedures. At completion of work, he shall remove all his tools, scaffolding, surplus materials, and rubbish from building and site. He shall leave premises and his work in a clean orderly condition acceptable to the Architect/Engineer.

1.11 ELECTRICAL WORK FOR MECHANICAL SYSTEMS

- A. Factory installed starters, controllers, and control equipment mounted in manufactured mechanical equipment necessary for mechanical equipment operation shall be furnished under Division 23.
- B. Power wiring for motors and installation of starters shall be under Division 26 Electrical.
- C. Temperature, humidity, pressure and similar controls essential to the operation of mechanical systems, and wiring and conduit thereof, including interlock wiring, shall be under Division 23 of specifications, installed in accordance with requirements of Division 26.
- D. Motors shall be furnished under Division 23 of capacity required to operate equipment specified, but shall not be less than that specified.
- E. Furnish and install all low voltage (120V and under) temperature control wiring for equipment provided under this division.
- F. Provide conduit when required for control wiring.

1.12 MOTORS

- A. All motors shall be furnished and installed under Division 23 and shall be wired under Division 26 Electrical.
- B. All motors shall be built in accordance with the current applicable IEEE, ASA, and NEMA standards. All general purpose motors shall be open drip-proof machines for installation indoors and/or in protected locations. Totally enclosed fan cooled (TEFC) motors shall be used in all areas of exposure to weather or other environmental contamination. Motors shall be rated explosion proof when located in hazardous atmospheres. Type II weather protected motors may be used in lieu of TEFC motors on roof mounted fan units and similar equipment.
- C. Unless indicated otherwise, motors shall be NEMA Design B with a service factor of 1.15 with total temperature rise of 90 degrees C. (resistance measured) in 40 degrees C. ambient when powered from the system voltage feeding the motor. TEFC motors shall have a

service factor of 1.00 with total temperature rise of 80 degrees C. in the above conditions. Motors located in areas exceeding 40 degrees C. ambient shall be factory rated for the ambient temperature of the motor environment. Single phase motors shall generally be NEMA Design N split phase induction motors with built-in thermal protectors. Single phase motors connected on loads requiring high starting torque shall be capacitor-start induction motors. Single phase motors of 1/10 HP or less may be shaded pole induction motors.

- D. If the Contractor proposes to furnish motors varying in horsepower and/or characteristics from those specified, he shall first inform the Architect/Engineer of the change and shall then coordinate the change and shall pay all additional charges in connection with the change.
- E. All motors supplied on this project three (3) HP and larger shall have a power factor not less than 85 percent under rated load conditions. Power factor of less than 85 percent shall be corrected to at least 90 percent under rated load conditions. Power factor corrective devices, installed to comply with this Code, shall be switched with the utilization equipment.
- F. All motors supplied on this project shall be energy efficient. All efficiency testing and labeling shall be performed in accordance with the NEMA Standard MG 1-12.54 and IEEE 112 Test Standard, Method B. Minimum efficiencies shall conform to the following listing:

<u>Motor HP</u>	<u>Efficiency (%)</u>
3/4	80.0
1	82.5
1-1/2	84.0
2	85.5
3	87.5
5	87.5
7-1/2	89.5
10	89.5
15	91.0
20	91.7

1.13 QUIET OPERATION AND VIBRATION

- A. All equipment provided under this section shall operate under all conditions of load free of objectionable sound and vibration. Sound and vibration conditions considered objectionable shall be corrected in an approved manner.
- B. Vibration and sound control shall be by means of approved vibration eliminators or sound attenuators in a manner as specified and as recommended by the manufacturer.

1.14 EQUIPMENT IDENTIFICATION

- A. Each unit shall be identified by its system number and other appropriate designation by stenciling in letters of approved size and wording. Equipment requiring identification shall include: supply and exhaust fans, air conditioning and heating machinery and apparatus, pumps, piping, control cabinets, and other equipment units as may be directed by the Architect/Engineer.

1.15 CLEANING AND ADJUSTMENTS

- A. Upon completion of the work, Contractor shall clean and lubricate fans, motors, and other running equipment and apparatus which he has installed and make certain such apparatus and mechanisms are in proper working order and ready to test.
- B. Scratched or damaged painting shall be touched up as necessary to return the painting to "new" condition and appearance.
- C. All piping and equipment shall be thoroughly blown out under pressure and cleared of all foreign matter, wasting air, gas or water through temporary connections as long as necessary to thoroughly clean system before system is placed in operation. Use every precaution to prevent pipe compound, scale, dirt, welding and other objectionable matter from getting into the piping system and equipment.
- D. During blow out period, baskets from strainers shall be removed, traps and control valves, etc., shall be by-passed.
- E. All cleaning shall be done prior to any sterilization, pressure testing, flow balancing or equipment adjustment procedures.
- F. During construction protect all piping and equipment from damage and dirt. Cap the open ends of all piping and equipment.

1.16 DEMOLITION

- A. Demolition shall be as shown on drawings or specified.
- B. Schedule all demolition work with Owner to cause minimum downtime of any building service or function. No extra cost to the contract will be allowed for overtime work unless specifically authorized in advance by representative of Owner in writing.
- C. During demolition and construction protect from damage all existing equipment and services that are to remain. Repair or replace any damage to existing facilities at no extra cost to the contract.
- D. Remove with care and deliver to a location designated by representative of the Owner all items designated to remain the property of the Owner.
- E. Drawings are diagrammatic and shown only major obstructions; coordinate with other trades for removal or relocation of pipes; conduits, hangers, etc. in path of work.
- F. No columns, beams, joists, building foundations or any other structural building component shall be cut, drilled or disturbed in any way. Conflicts shall immediately be brought to the attention of the Architect/Engineer. Contractor shall not proceed until instructed in writing by the Architect/Engineer if conflicts between mechanical work and structural elements occur.

1.17 CONNECTIONS TO EXISTING WORK

- A. Plan installation of new work and connections to existing work to insure minimum interference with regular operation of existing facilities.

- B. Submit to the Owner for approval, a schedule of necessary temporary shut-downs of existing services. All shutdowns shall be made at such times as will not interfere with regular operating of existing facilities and only after written approval of the Owner.
- C. To insure continuous operation, make necessary temporary connections between new and existing work.
- D. Connect new work to existing work in neat and approved manner. Restore existing work disturbed to original condition.

1.18 WATERPROOFING

- A. Where any work pierces waterproofing including waterproof concrete, the method of installation shall be as approved by the Owner before the work is done.
- B. Provide all necessary sleeves, caulking and flashing required to make openings absolutely watertight. Waterproof flashing materials shall be compatible with base materials.

1.19 TESTS

- A. Contractor shall make all tests required to establish the adequacy, quality, safety, completed status and satisfactory operation of all systems to the satisfaction of the Architect/Engineer. Provide all instruments, labor and services necessary to conduct tests.

1.20 INSTRUCTIONS

- A. Fully instruct Owner's personnel in the care and operation of mechanical systems and furnish a letter to the Architect/Engineer advising the particular person who has received such instruction.

1.21 WARRANTY

- A. Equipment shall be started, tested, adjusted, and placed in satisfactory operating condition. Furnish a letter addressed to the Architect/Engineer advising that the completed systems have been installed in accordance with the Plans and Specifications and that they are in proper operating condition. The Owner shall receive a written warranty covering all defects in workmanship and material for a period of one year from date of final acceptance. Any defects appearing within this one year period shall be repaired without additional cost to the Owner.

1.22 ACCEPTANCE

- A. Before requesting final inspection:
 - 1. Complete all work required. If any items are held in abeyance as incomplete for final inspection, list such items together with explanation for delay.
 - 2. Submit statement that equipment is properly installed, adjusted, fully lubricated and operation is satisfactory.
 - 3. Certify in writing to the Architect/Engineer that the Owner's representative has been instructed as to the care and operation of the system and that catalog service and maintenance information has been turned over to the Architect/Engineer.

4. Submit copy of written guarantee.
 5. Submit copy of other data as may be outlined in these specifications.
- B. Copies of the above data shall be submitted to the Architect/Engineer prior to requesting final inspection.

1.23 FACILITY STARTUP BROCHURE

- A. At the completion of work, Contractor shall provide startup instruction in accordance with Division 00, "Closeout" and shall submit a bound brochure containing the following:
1. Shop Drawings
 2. Maintenance Manuals
 3. Control Wiring and Piping Diagrams
 4. Operating Instructions
 5. Copy of Guarantee
 6. Certificate of Instruction of Owner's Representative
 7. Certificate of Job Completion
 8. Record Documents
- B. Where projects are of sufficient size to make a single brochure impractical, several brochures shall be prepared by trade and As-Built Drawings may be submitted as a separate item.
- C. Brochure shall be indexed and divided for reasonable clarity.
- D. Brochure shall be turned over to the Architect/Engineer for review and approval. The contractor shall make modifications to the brochure as deemed necessary for compliance and clarity, by the Architect/Engineer, and re-submit the final brochure to the Architect/Engineer to be forwarded to the Owner.

END OF SECTION 23 00 00

SECTION 23 05 13
COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00.
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) requirements.

1.03 SUMMARY

- A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.04 COORDINATION

- A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
 - 1. Motor controllers.
 - 2. Torque, speed, and horsepower requirements of the load.
 - 3. Ratings and characteristics of supply circuit and required control sequence.
 - 4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.01 GENERAL MOTOR REQUIREMENTS

- A. Comply with NEMA MG 1 unless otherwise indicated.

2.02 MOTOR CHARACTERISTICS

- A. Duty: Continuous duty at ambient temperature of 40°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.

2.03 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. Rotor: Random-wound, squirrel cage.
- F. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
- G. Temperature Rise: Match insulation rating.
- H. Insulation: Class F.
- I. 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.
- J. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.04 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:
 - 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.

2.05 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.

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 23 05 13

SECTION 23 05 16
EXPANSION FITTINGS AND LOOPS FOR HVAC PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00.
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) requirements.

1.03 SUMMARY

- A. Section Includes:
 - 1. Rubber union connector packless expansion joints.
 - 2. Alignment guides and anchors.
 - 3. Pipe loops and swing connections.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Delegated-Design Submittal: For each anchor and alignment guide, including analysis data, signed and sealed by the qualified professional engineer registered in the State of Florida that is responsible for their preparation.
 - 1. Design Calculations: Calculate requirements for thermal expansion of piping systems and for selecting and designing expansion joints, loops, and swing connections.
 - 2. Anchor Details: Detail fabrication of each anchor indicated. Show dimensions and methods of assembly and attachment to building structure.
 - 3. Alignment Guide Details: Detail field assembly and attachment to building structure.
 - 4. Schedule: Indicate type, manufacturer's number, size, material, pressure rating, end connections, and location for each expansion joint.

1.05 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

1.06 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For expansion joints to include in maintenance manuals.

1.07 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe and Pressure-Vessel Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Compatibility: Products shall be suitable for piping service fluids, materials, working pressures, and temperatures.
- B. Capability: Products to absorb 200 percent of maximum axial movement between anchors.

2.02 PACKLESS EXPANSION JOINTS

- A. Rubber Union Connector Expansion Joints:
 - 1. Material: Twin reinforced-rubber spheres with external restraining cables.
 - 2. Minimum Pressure Rating: 150 psig at 170°F , unless otherwise indicated.
 - 3. End Connections for NPS 2 and Smaller: Threaded.

2.03 ALIGNMENT GUIDES AND ANCHORS

- A. Alignment Guides:
 - 1. Description: Steel, factory-fabricated alignment guide, with bolted two-section outer cylinder and base for attaching to structure; with two-section guiding slider for bolting to pipe.
- B. Anchor Materials:
 - 1. Steel Shapes and Plates: ASTM A 36/A 36M.
 - 2. Bolts and Nuts: ASME B18.10 or ASTM A 183, steel hex head.
 - 3. Washers: ASTM F 844, steel, plain, flat washers.
 - 4. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened portland cement concrete, with tension and shear capacities appropriate for application.
 - a. Stud: Threaded, zinc-coated carbon steel.
 - b. Expansion Plug: Zinc-coated steel.

- c. Washer and Nut: Zinc-coated steel.
- 5. Chemical Fasteners: Insert-type stud, bonding-system anchor for use with hardened portland cement concrete, with tension and shear capacities appropriate for application.
 - a. Bonding Material: ASTM C 881/C 881M, Type IV, Grade 3, two-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.
 - b. Stud: ASTM A 307, zinc-coated carbon steel with continuous thread on stud, unless otherwise indicated.
 - c. Washer and Nut: Zinc-coated steel.

PART 3 - EXECUTION

3.01 EXPANSION JOINT INSTALLATION

- A. Install expansion joints of sizes matching sizes of piping in which they are installed.
- B. Install packed-type expansion joints with packing suitable for fluid service.
- C. Install metal-bellows expansion joints according to EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."
- D. Install rubber packless expansion joints according to FSA-PSJ-703.

3.02 PIPE LOOP AND SWING CONNECTION INSTALLATION

- A. Install pipe loops cold-sprung in tension or compression as required to partly absorb tension or compression produced during anticipated change in temperature.
- B. Connect risers and branch connections to mains with at least five pipe fittings, including tee in main.
- C. Connect risers and branch connections to terminal units with at least four pipe fittings, including tee in riser.
- D. Connect mains and branch connections to terminal units with at least four pipe fittings, including tee in main.

3.03 ALIGNMENT-GUIDE AND ANCHOR INSTALLATION

- A. Install alignment guides to guide expansion and to avoid end-loading and torsional stress.
- B. Install one guide(s) on each side of pipe expansion fittings and loops. Install guides nearest to expansion joint not more than four pipe diameters from expansion joint.
- C. Attach guides to pipe, and secure guides to building structure.
- D. Install anchors at locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.

- E. Anchor Attachments:
 - 1. Anchor Attachment to Steel Pipe: Attach by welding. Comply with ASME B31.9 and ASME Boiler and Pressure Vessel Code: Section IX, “Welding and Brazing Qualifications.”
 - 2. Anchor Attachment to Copper Tubing: Attach with pipe hangers. Use MSS SP-69, Type 24; U bolts bolted to anchor.
- F. Fabricate and install steel anchors by welding steel shapes, plates, and bars. Comply with ASME B31.9 and AWS D1.1/D1.1M.
 - 1. Anchor Attachment to Steel Structural Members: Attach by welding.
 - 2. Anchor Attachment to Concrete Structural Members: Attach by fasteners. Follow fastener manufacturer's written instructions.
- G. Use grout to form flat bearing surfaces for guides and anchors attached to concrete.

END OF SECTION 23 05 16

SECTION 23 05 17
SLEEVES AND SLEEVE SEALS FOR HVAC PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00.
 - 1. Refer to "PART 2 – PRODUCTS" for all Buy America Build America Act (BABA) requirements.

1.03 SUMMARY

- A. Section Includes:
 - 1. Sleeves.
 - 2. Sleeve-seal systems.
 - 3. Grout.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

PART 2 - PRODUCTS

2.01 SLEEVES

- 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. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

2.02 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: Stainless steel.
3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.03 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.

PART 3 - EXECUTION

3.01 SLEEVE INSTALLATION

- A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
- B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.
 1. Sleeves are not required for core-drilled holes.
- C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
 1. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.
 2. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.
- D. Install sleeves for pipes passing through interior partitions.
 1. Cut sleeves to length for mounting flush with both surfaces.
 2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
 3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Section 07 92 00 "Joint Sealants."

- E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 078413 “Penetration Firestopping.”

3.02 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.
- B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.03 SLEEVE AND SLEEVE-SEAL SCHEDULE

- A. Use sleeves and sleeve seals for the following piping-penetration applications:
 - 1. Exterior Concrete Walls above Grade:
 - a. Piping Smaller Than NPS 6 Galvanized-steel wall sleeves.
 - 2. Exterior Concrete Walls below Grade:
 - a. Piping Smaller Than NPS 6: Galvanized-steel wall sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
 - b. Piping NPS 6 and Larger: Galvanized-steel wall sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
 - 3. Concrete Slabs-on-Grade:
 - a. Piping Smaller Than NPS 6: Galvanized-steel wall sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
 - b. Piping NPS 6 and Larger: Galvanized-steel wall sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
 - 4. Interior Partitions:
 - a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves.

- b. Piping NPS 6 and Larger: Galvanized-steel-sheet sleeves.

END OF SECTION 23 05 17

SECTION 23 05 19
METERS AND GAGES FOR HVAC PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00.
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) requirements.

1.03 SUMMARY

- A. Section Includes:
 - 1. Liquid-in-glass thermometers.
 - 2. Thermowells.
 - 3. Dial-type pressure gages.
 - 4. Gage attachments.
 - 5. Test plugs.
 - 6. Turbine flowmeters.
 - 7. Venturi flowmeters.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Wiring Diagrams: For power, signal, and control wiring.

1.05 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of meter and gage, from manufacturer.

1.06 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.01 LIQUID-IN-GLASS THERMOMETERS

- A. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:
1. Standard: ASME B40.200.
 2. Case: Cast aluminum; 9-inch nominal size unless otherwise indicated.
 3. Case Form: Adjustable angle unless otherwise indicated.
 4. Tube: Glass with magnifying lens and blue or red organic liquid.
 5. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F.
 6. Window: Glass.
 7. Stem: Aluminum and of length to suit installation.
 - a. Design for Air-Duct Installation: With ventilated shroud.
 - b. Design for Thermowell Installation: Bare stem.
 8. Connector: 1-1/4 inches, with ASME B1.1 screw threads.
 9. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

2.02 THERMOWELLS

- A. Thermowells:
1. Standard: ASME B40.200.
 2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
 3. Material for Use with Copper Tubing: CNR.
 4. Material for Use with Steel Piping: CRES.
 5. Type: Stepped shank unless straight or tapered shank is indicated.
 6. External Threads: NPS 1/2, NPS 3/4, or NPS 1, ASME B1.20.1 pipe threads.
 7. Internal Threads: 1/2, 3/4, and 1 inch, with ASME B1.1 screw threads.
 8. Bore: Diameter required to match thermometer bulb or stem.
 9. Insertion Length: Length required to match thermometer bulb or stem.
 10. Lagging Extension: Include on thermowells for insulated piping and tubing.

11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

B. Heat-Transfer Medium: Mixture of graphite and glycerin.

2.03 PRESSURE GAGES

A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:

1. Standard: ASME B40.100.
2. Case: Liquid-filled Sealed; brass; 4-1/2-inch nominal diameter.
3. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
4. Pressure Connection: Brass, with NPS 1/4 or 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
5. Movement: Mechanical, with link to pressure element and connection to pointer.
6. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.
7. Pointer: Dark-colored metal.
8. Window: Glass.
9. Ring: Brass.
10. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

2.04 GAGE ATTACHMENTS

- A. Snubbers: ASME B40.100, brass; with NPS 1/4, ASME B1.20.1 pipe threads and piston-type surge-dampening device. Include extension for use on insulated piping.
- B. Siphons: Loop-shaped section of brass pipe with NPS 1/4 pipe threads.
- C. Valves: Brass ball, with NPS 1/4, ASME B1.20.1 pipe threads.

2.05 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 1/2, ASME B1.20.1 pipe thread.
- D. Minimum Pressure and Temperature Rating: 500 psig at 200°F.
- E. Core Inserts: EPDM self-sealing rubber.

2.06 FLOWMETERS

A. Turbine Flowmeters:

1. Description: Flowmeter with sensor and indicator.
2. Flow Range: Sensor and indicator shall cover operating range of equipment or system served.
3. Sensor: Impeller turbine; for inserting into pipe fitting or for installing in piping and measuring flow directly in gallons per minute.
 - a. Design: Device or pipe fitting with inline turbine and integral direct-reading scale for water.
 - b. Construction: Bronze or stainless-steel body, with plastic turbine or impeller.
 - c. Minimum Pressure Rating: 150 psig.
 - d. Minimum Temperature Rating: 180°F.
4. Indicator: Hand-held meter; either an integral part of sensor or a separate meter.
5. Accuracy: Plus or minus 1-1/2 percent.
6. Display: Shows rate of flow[, with register to indicate total volume in gallons.
7. Operating Instructions: Include complete instructions with each flowmeter.

B. Venturi Flowmeters:

1. Description: Flowmeter with calibrated flow-measuring element, hoses or tubing, fittings, valves, indicator, and conversion chart.
2. Flow Range: Sensor and indicator shall cover operating range of equipment or system served.
3. Sensor: Venturi-type, calibrated, flow-measuring element; for installation in piping.
 - a. Design: Differential-pressure-type measurement for water.
 - b. Construction: Bronze, brass, or factory-primed steel, with brass fittings and attached tag with flow conversion data.
 - c. Minimum Pressure Rating: 250 psig.
 - d. Minimum Temperature Rating: 250°F.
 - e. End Connections for NPS 2 and Smaller: Threaded.
 - f. End Connections for NPS 2-1/2 and Larger: Flanged or welded.

- g. Flow Range: Flow-measuring element and flowmeter shall cover operating range of equipment or system served.
- 4. Permanent Indicators: Meter suitable for wall or bracket mounting, calibrated for connected flowmeter element, and having 6-inch- diameter dial with fittings and copper tubing for connecting to flowmeter element.
 - a. Scale: Gallons per minute.
 - b. Accuracy: Plus or minus 1 percent between 20 and 80 percent of scale range.
- 5. Display: Shows rate of flow, with register to indicate total volume in gallons.
- 6. Conversion Chart: Flow rate data compatible with sensor.
- 7. Operating Instructions: Include complete instructions with each flowmeter.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install thermowells with socket extending to center of pipe and in vertical position in piping tees.
- B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.
- C. Install thermowells with extension on insulated piping.
- D. Fill thermowells with heat-transfer medium.
- E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.
- F. Install remote-mounted thermometer bulbs in thermowells and install cases on panels; connect cases with tubing and support tubing to prevent kinks. Use minimum tubing length.
- G. Install duct-thermometer mounting brackets in walls of ducts. Attach to duct with screws.
- H. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.
- I. Install remote-mounted pressure gages on panel.
- J. Install valve and snubber in piping for each pressure gage for fluids (except steam).
- K. Install valve and syphon fitting in piping for each pressure gage for steam.
- L. Install test plugs in piping tees.
- M. Install flow indicators in piping systems in accessible positions for easy viewing.
- N. Assemble and install connections, tubing, and accessories between flow-measuring elements and flowmeters according to manufacturer's written instructions.

- O. Install flowmeter elements in accessible positions in piping systems.
- P. Install wafer-orifice flowmeter elements between pipe flanges.
- Q. Install differential-pressure-type flowmeter elements, with at least minimum straight lengths of pipe, upstream and downstream from element according to manufacturer's written instructions.
- R. Install permanent indicators on walls or brackets in accessible and readable positions.
- S. Install connection fittings in accessible locations for attachment to portable indicators.
- T. Install thermometers in the following locations:
 - 1. Two inlets and two outlets of each chiller.
 - 2. Inlet and outlet of each hydronic coil in air-handling units.
 - 3. Outside-, return-, supply-, and mixed-air ducts.
- U. Install pressure gages in the following locations:
 - 1. Discharge of each pressure-reducing valve.
 - 2. Inlet and outlet of each chiller chilled-water connection.
 - 3. Suction and discharge of each pump.

3.02 CONNECTIONS

- A. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.
- B. Connect flowmeter-system elements to meters.
- C. Connect flowmeter transmitters to meters.
- D. Connect thermal-energy meter transmitters to meters.

3.03 ADJUSTING

- A. After installation, calibrate meters according to manufacturer's written instructions.
- B. Adjust faces of meters and gages to proper angle for best visibility.

3.04 THERMOMETER SCALE-RANGE SCHEDULE

- A. Scale Range for Chilled-Water Piping: 0 to 100°F.
- B. Scale Range for Air Ducts: 20 to 240°F.

3.05 PRESSURE-GAGE SCALE-RANGE SCHEDULE

- A. Scale Range for Chilled-Water Piping: 0 to 100 psi.

3.06 FLOWMETER SCHEDULE

- A. Flowmeters for Chilled-Water Piping: Turbine Venturi type as shown in he drawings.

END OF SECTION 23 05 19

SECTION 23 05 23.12
BALL VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00.
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) requirements.

1.03 SUMMARY

- A. Section Includes:
 - 1. Bronze ball valves.

1.04 DEFINITIONS

- A. CWP: Cold working pressure.
- B. SWP: Steam working pressure.

1.05 ACTION SUBMITTALS

- A. Product Data: For each type of valve.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
 - 1. Protect internal parts against rust and corrosion.
 - 2. Protect threads, flange faces, and weld ends.
 - 3. Set ball valves open to minimize exposure of functional surfaces.
- B. Use the following precautions during storage:
 - 1. Maintain valve end protection.
 - 2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
- C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use operating handles or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS FOR VALVES

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
- B. ASME Compliance:
 - 1. ASME B1.20.1 for threads for threaded-end valves.
 - 2. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
 - 3. ASME B16.18 for solder-joint connections.
 - 4. ASME B31.1 for power piping valves.
 - 5. ASME B31.9 for building services piping valves.
- C. 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.
- D. Refer to HVAC valve schedule articles for applications of valves.
- 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 Actuator Types:
 - 1. Handlever: For quarter-turn valves smaller than NPS 4.
- H. Valves in Insulated Piping:
 - 1. Include 2-inch stem extensions.
 - 2. Extended operating handle of nonthermal-conductive material, and protective sleeves that allow operation of valves without breaking the vapor seals or disturbing insulation.
 - 3. Memory stops that are fully adjustable after insulation is applied.
- I. Valve Bypass and Drain Connections: MSS SP-45.

2.02 BRONZE BALL VALVES

- A. One-Piece Bronze Ball Valves with Bronze Trim:
 - 1. Description:
 - a. Standard: MSS SP-110.
 - b. CWP Rating: 400 psig.

- c. Body Design: One piece.
- d. Body Material: Bronze.
- e. Ends: Threaded.
- f. Seats: PTFE.
- g. Stem: Bronze.
- h. Ball: Chrome-plated brass.
- i. Port: Reduced.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- E. Do not attempt to repair defective valves; replace with new valves.

3.02 VALVE INSTALLATION

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem movement.
- E. Install valve tags. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for valve tags and schedules.

3.03 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If valves with specified SWP classes or CWP ratings are unavailable, the same types of valves with higher SWP classes or CWP ratings may be substituted.
- B. Select valves with the following end connections:

1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
2. For Steel Piping, NPS 2 and Smaller: Threaded ends.

3.04 CHILLED-WATER VALVE SCHEDULE

- A. Pipe NPS 2 and Smaller: One piece, full port, bronze trim.
 1. Valves may be provided with solder-joint ends instead of threaded ends.

END OF SECTION 23 05 23.12

SECTION 23 05 23.13
BUTTERFLY VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00.
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) requirements.

1.03 SUMMARY

- A. Section Includes:
 - 1. Iron, single-flange butterfly valves.
 - 2. High-performance butterfly valves.
 - 3. Chainwheels.

1.04 DEFINITIONS

- A. CWP: Cold working pressure.
- B. EPDM: Ethylene propylene copolymer rubber.
- C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
- D. SWP: Steam working pressure.

1.05 ACTION SUBMITTALS

- A. Product Data: For each type of valve.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
 - 1. Protect internal parts against rust and corrosion.
 - 2. Protect threads, flange faces, grooves, and weld ends.
 - 3. Set butterfly valves closed or slightly open.
- B. Use the following precautions during storage:

1. Maintain valve end protection.
 2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
- C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS FOR VALVES

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
- B. ASME Compliance:
1. ASME B16.1 for flanges on iron valves.
 2. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
 3. ASME B31.1 for power piping valves.
 4. ASME B31.9 for building services piping valves.
- C. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- D. Valve Sizes: Same as upstream piping unless otherwise indicated.
- E. Valve Actuator Types:
1. Gear Actuator: For valves NPS 8 and larger.
 2. Handlever: For valves NPS 6 and smaller.
 3. Chainwheel: Device for attachment to gear, stem, or other actuator of size and with chain for mounting height, according to "Valve Installation" Article.
- F. Valves in Insulated Piping: With 2-inch stem extensions with extended necks.

2.02 IRON, SINGLE-FLANGE BUTTERFLY VALVES

- A. Iron, Single-Flange Butterfly Valves with Aluminum-Bronze Disc:
1. Description:
 - a. Standard: MSS SP-67, Type I.
 - b. CWP Rating: 150 psig.
 - c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.

- d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
- e. Seat: EPDM.
- f. Stem: One- or two-piece stainless steel.
- g. Disc: Aluminum bronze.

2.03 HIGH-PERFORMANCE BUTTERFLY VALVES

A. Class 150, Single-Flange, High-Performance Butterfly Valves:

- 1. Description:
 - a. Standard: MSS SP-68.
 - b. CWP Rating: 285 psig at 100°F.
 - c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
 - d. Body Material: Carbon steel, cast iron, ductile iron, or stainless steel.
 - e. Seat: Reinforced PTFE or metal.
 - f. Stem: Stainless steel; offset from seat plane.
 - g. Disc: Carbon steel.
 - h. Service: Bidirectional.

2.04 CHAINWHEELS

- A. Description: Valve actuation assembly with sprocket rim, chain guides, chain, and attachment brackets for mounting chainwheels directly to hand wheels.
 - 1. Sprocket Rim with Chain Guides: Ductile iron, of type and size required for valve. Include zinc or epoxy coating.
 - 2. Chain: Hot-dip, galvanized steel, of size required to fit sprocket rim.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine mating flange faces for damage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

- D. Do not attempt to repair defective valves; replace with new valves.

3.02 VALVE INSTALLATION

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem movement.
- E. Install chainwheels on operators for butterfly valves NPS 4 and larger and more than 96 inches above floor. Extend chains to 60 inches above finished floor.
- F. Install valve tags. Comply with requirements in Section 230553 “Identification for HVAC Piping and Equipment” for valve tags and schedules.

3.03 ADJUSTING

- A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.04 CHILLED-WATER VALVE SCHEDULE

- A. Pipe NPS 6 and Larger:
 - 1. Iron, Single-Flange Butterfly Valves, NPS 6 to NPS 12: 200 CWP, EPDM seat, aluminum-bronze disc.
 - 2. High-Performance Butterfly Valves: Class 150, single flange.

END OF SECTION 23 05 23.13

SECTION 23 05 23.14
CHECK VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00.
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) requirements.

1.03 SUMMARY

- A. Section Includes:
 - 1. Bronze swing check valves.
 - 2. Iron swing check valves.

1.04 DEFINITIONS

- A. CWP: Cold working pressure.
- B. EPDM: Ethylene propylene copolymer rubber.
- C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
- D. SWP: Steam working pressure.

1.05 ACTION SUBMITTALS

- A. Product Data: For each type of valve.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
 - 1. Protect internal parts against rust and corrosion.
 - 2. Protect threads, flange faces, grooves, and weld ends.
 - 3. Block check valves in either closed or open position.
- B. Use the following precautions during storage:
 - 1. Maintain valve end protection.

2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
- C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS FOR VALVES

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
- B. 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 B31.1 for power piping valves.
 6. ASME B31.9 for building services piping valves.
- C. AWWA Compliance: Comply with AWWA C606 for grooved-end connections.
- 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.

2.02 BRONZE SWING CHECK VALVES

- A. Class 125, Bronze Swing Check Valves with Bronze Disc:
1. Description:
 - a. Standard: MSS SP-80, Type 3.
 - b. CWP Rating: 200 psig.
 - c. Body Design: Horizontal flow.
 - d. Body Material: ASTM B 62, bronze.

- e. Ends: Threaded.
- f. Disc: Bronze.

2.03 IRON SWING CHECK VALVES

A. Class 125, Iron Swing Check Valves with Metal Seats:

- 1. Description:
 - a. Standard: MSS SP-71, Type I.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 150 psig.
 - d. Body Design: Clear or full waterway.
 - e. Body Material: ASTM A 126, gray iron with bolted bonnet.
 - f. Ends: Flanged.
 - g. Trim: Bronze.
 - h. Gasket: Asbestos free.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- E. Do not attempt to repair defective valves; replace with new valves.

3.02 VALVE INSTALLATION

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem movement.

- E. Install check valves for proper direction of flow in horizontal position with hinge pin level.
- F. Install valve tags. Comply with requirements for valve tags and schedules in Section 230553 "Identification for HVAC Piping and Equipment."

3.03 ADJUSTING

- A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.04 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If valve applications are not indicated, use the following:
 - 1. Pump-Discharge Check Valves:
 - a. NPS 2 and Smaller: Bronze swing check valves with bronze disc.
 - b. NPS 2-1/2 and Larger: Iron swing check valves with lever and weight or with spring or iron, center-guided, resilient-seat check valves.
- B. If valves with specified SWP classes or CWP ratings are unavailable, the same types of valves with higher SWP classes or CWP ratings may be substituted.
- C. Select valves, except wafer types, with the following end connections:
 - 1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules.
 - 2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules.
 - 3. For Copper Tubing, NPS 5 and Larger: Flanged ends.
 - 4. For Steel Piping, NPS 2 and Smaller: Threaded ends.
 - 5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules.
 - 6. For Steel Piping, NPS 5 and Larger: Flanged ends.

3.05 CHILLED-WATER VALVE SCHEDULE

- A. Pipe NPS 2 and Smaller:
 - 1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
 - 2. Bronze Swing Check Valves: Class 125, bronze disc.
- B. Pipe NPS 2-1/2 and Larger:
 - 1. Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
 - 2. Iron Swing Check Valves: Class 125 metal seats.

END OF SECTION 23 05 23.14

SECTION 23 05 23.15
GATE VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00.
 - 1. Refer to "PART 2 – PRODUCTS" for all Buy America Build America Act (BABA) requirements.

1.03 SUMMARY

- A. Section Includes:
 - 1. Bronze gate valves.
 - 2. Iron gate valves.
 - 3. Chainwheels.

1.04 DEFINITIONS

- A. CWP: Cold working pressure.
- B. NRS: Nonrising stem.
- C. OS&Y: Outside screw and yoke.
- D. RS: Rising stem.
- E. SWP: Steam working pressure.

1.05 ACTION SUBMITTALS

- A. Product Data: For each type of valve.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
 - 1. Protect internal parts against rust and corrosion.
 - 2. Protect threads, flange faces, grooves, and weld ends.
 - 3. Set gate valves closed to prevent rattling.

- B. Use the following precautions during storage:
 - 1. Maintain valve end protection.
 - 2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
- C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS FOR VALVES

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
- B. 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 B31.1 for power piping valves.
 - 6. ASME B31.9 for building services piping valves.
- C. 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.
- D. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- E. Valve Sizes: Same as upstream piping unless otherwise indicated.
- F. RS Valves in Insulated Piping: With 2-inch stem extensions.
- G. Valve Bypass and Drain Connections: MSS SP-45.

2.02 BRONZE GATE VALVES

- A. Class 125, NRS, Bronze Gate Valves:
 - 1. Description:
 - a. Standard: MSS SP-80, Type 1.
 - b. CWP Rating: 200 psig.

- c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
- d. Ends: Threaded or solder joint.
- e. Stem: Bronze.
- f. Disc: Solid wedge; bronze.
- g. Packing: Asbestos free.
- h. Handwheel: Malleable iron, bronze, or aluminum.

2.03 IRON GATE VALVES

A. Class 125, NRS, Iron Gate Valves:

1. Description:

- a. Standard: MSS SP-70, Type I.
- b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
- c. NPS 14 to NPS 24, CWP Rating: 150 psig.
- d. Body Material: ASTM A 126, gray iron with bolted bonnet.
- e. Ends: Flanged.
- f. Trim: Bronze.
- g. Disc: Solid wedge.
- h. Packing and Gasket: Asbestos free.

2.04 CHAINWHEELS

A. Description: Valve actuation assembly with sprocket rim, chain guides, chain, and attachment brackets for mounting chainwheels directly to hand wheels.

- 1. Sprocket Rim with Chain Guides: Ductile iron, of type and size required for valve. Include zinc or epoxy coating.
- 2. Chain: Hot-dip-galvanized steel, of size required to fit sprocket rim.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- E. Do not attempt to repair defective valves; replace with new valves.

3.02 VALVE INSTALLATION

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem movement.
- E. Install chainwheels on operators for gate valves NPS 4 and larger and more than 96 inches above floor. Extend chains to 60 inches above finished floor.
- F. Install valve tags. Comply with requirements in Section 230553 “Identification for HVAC Piping and Equipment” for valve tags and schedules.

3.03 ADJUSTING

- A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.04 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If valve applications are not indicated, use the following:
 - 1. Shutoff Service: Gate valves.
- B. If valves with specified SWP classes or CWP ratings are unavailable, the same types of valves with higher SWP classes or CWP ratings may be substituted.
- C. Select valves, except wafer types, with the following end connections:
 - 1. For Copper Tubing, NPS 2 and Smaller: Threaded ends, except where solder-joint valve-end option is indicated in valve schedules below.
 - 2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends, except where threaded valve-end option is indicated in valve schedules below.
 - 3. For Copper Tubing, NPS 5 and Larger: Flanged ends.
 - 4. For Steel Piping, NPS 2 and Smaller: Threaded ends.
 - 5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends, except where threaded valve-end option is indicated in valve schedules below.
 - 6. For Steel Piping, NPS 5 and Larger: Flanged ends.

3.05 CHILLED-WATER VALVE SCHEDULE

- A. Pipe NPS 2 and Smaller: Bronze Valves, Class 125, NRS with soldered or threaded ends.
- B. Pipe NPS 2-1/2 and Larger: Iron Gate Valves, Class 125, NRS .

END OF SECTION 23 05 23.15

SECTION 23 05 23.16
PLUG VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00.
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) requirements.

1.03 SUMMARY

- A. Section Includes:
 - 1. Lubricated plug valves.

1.04 DEFINITIONS

- A. CWP: Cold working pressure.

1.05 ACTION SUBMITTALS

- A. Product Data: For each type of valve.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
 - 1. Protect internal parts against rust and corrosion.
 - 2. Protect threads, flange faces, grooves, and weld ends.
 - 3. Set plug valves open to minimize exposure of functional surfaces.
- B. Use the following precautions during storage:
 - 1. Maintain valve end protection.
 - 2. Store valves indoors and maintain at higher-than-ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
- C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS FOR VALVES

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
- B. 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 B31.1 for power piping valves.
 - 5. ASME B31.9 for building services piping valves.
- C. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- D. Valve Sizes: Same as upstream piping unless otherwise indicated.
- E. Valve Actuator Types: Wrench. Furnish Owner with one wrench for every five plug valves, for each size square plug-valve head.

2.02 LUBRICATED PLUG VALVES

- A. Class 125, Lubricated Plug Valves with Flanged Ends:
 - 1. Description:
 - a. Standard: MSS SP-78, Type II regular gland.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 150 psig.
 - d. Body Material: ASTM A 48/A 48M or ASTM A 126, cast iron with lubrication-sealing system.
 - e. Pattern: Regular.
 - f. Plug: Cast iron or bronze with sealant groove.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- E. Do not attempt to repair defective valves; replace with new valves.

3.02 VALVE INSTALLATION

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem movement.
- E. Install chainwheels on operators for plug valves NPS 4 and larger and more than 96 inches above floor. Extend chains to 60 inches above finished floor.
- F. Install valve tags. Comply with requirements for valve tags and schedules in Section 23 05 53 "Identification for HVAC Piping and Equipment."

3.03 ADJUSTING

- A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.04 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If valve applications are not indicated, use the following:
 - 1. Shutoff Service: Plug valves.
- B. If valves with CWP ratings are unavailable, the same types of valves with higher CWP ratings may be substituted.
- C. Select valves with the following end connections:
 - 1. For Copper Tubing, NPS 2 and Smaller: Threaded ends.
 - 2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules.
 - 3. For Copper Tubing, NPS 5 and Larger: Flanged ends.
 - 4. For Steel Piping, NPS 2 and Smaller: Threaded ends.
 - 5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules.

6. For Steel Piping, NPS 5 and Larger: Flanged ends.
7. For Grooved-End Copper Tubing and Steel Piping except Steam and Steam Condensate Piping: Valve ends may be grooved.

3.05 CHILLED-WATER VALVE SCHEDULE

A. Pipe NPS 2-1/2 and Larger:

1. Lubricated Plug Valves: Class 125, regular gland.

END OF SECTION 23 05 23.16

SECTION 23 05 29
HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00.
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) requirements.

1.03 SUMMARY

- A. Section Includes:
 - 1. Metal pipe hangers and supports.
 - 2. Trapeze pipe hangers.
 - 3. Thermal-hanger shield inserts.
 - 4. Fastener systems.
 - 5. Equipment supports.
- B. Related Sections:
 - 1. Section 05 50 00 “Metal Fabrications” for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
 - 2. Section 23 05 16 “Expansion Fittings and Loops for HVAC Piping” for pipe guides and anchors.
 - 3. Section 23 05 48.13 “Vibration Controls for HVAC” for vibration isolation devices.
 - 4. Section 23 31 13 “Metal Ducts” for duct hangers and supports.

1.04 DEFINITIONS

- A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.

1.05 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.06 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

PART 2 - PRODUCTS

2.01 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 galvanized steel.

B. Copper Pipe Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel.

2.02 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, 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.

2.03 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.04 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.

- B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
 - 1. Properties: Nonstaining, noncorrosive, and nongaseous.
 - 2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.01 HANGER AND SUPPORT INSTALLATION

- A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.
- B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
 - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
 - 2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- C. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- D. Fastener System Installation:
 - 1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
 - 2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- E. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- F. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- G. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- H. Install lateral bracing with pipe hangers and supports to prevent swaying.
- I. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before

concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

- J. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- K. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.
- L. Insulated Piping:
 - 1. Attach clamps and spacers to piping.
 - a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
 - b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
 - c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
 - 2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 - 3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 - 4. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
 - b. NPS 4: 12 inches long and 0.06 inch thick.
 - c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
 - d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
 - e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.
 - 5. Pipes NPS 8 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
 - 6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.02 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make bearing surface smooth.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.03 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.04 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.05 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.
- B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal must comply with Section 09 90 00 "Painting and Coating" and Section 09 96 10 "High Performance Coatings for Steel."
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.06 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use carbon-steel pipe hangers and supports metal trapeze pipe hangers and attachments for general service applications.
- F. Use stainless-steel pipe hangers and stainless-steel or corrosion-resistant attachments for hostile environment applications.
- G. Use copper-plated pipe hangers and copper attachments for copper piping and tubing.
- H. Use padded hangers for piping that is subject to scratching.
- I. Use thermal-hanger shield inserts for insulated piping and tubing.
- J. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
 - 2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050°F, pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.
 - 3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
 - 4. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
 - 5. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
 - 6. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
 - 7. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
 - 8. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.

9. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
- K. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.
- L. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
 2. Steel Clevises (MSS Type 14): For 120 to 450°F piping installations.
- M. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joint construction, to attach to top flange of structural shape.
 3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 6. C-Clamps (MSS Type 23): For structural shapes.
 7. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - a. Light (MSS Type 31): 750 lb.
 - b. Medium (MSS Type 32): 1500 lb.
 - c. Heavy (MSS Type 33): 3000 lb.
 8. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
 9. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.

- N. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- O. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
 2. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
 3. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
- P. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
- Q. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

END OF SECTION 23 05 29

SECTION 23 05 48.13
VIBRATION CONTROLS FOR HVAC

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00.
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) requirements.

1.03 SUMMARY

- A. Section Includes:
 - 1. Elastomeric isolation pads.
 - 2. Open-spring isolators.
 - 3. Resilient pipe guides.
 - 4. Elastomeric hangers.
 - 5. Spring hangers.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
 - 2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of vibration isolation device type required.
- B. Shop Drawings:
- C. Delegated-Design Submittal: For each vibration isolation device.
 - 1. Include design calculations for selecting vibration isolators and for designing vibration isolation bases.

1.05 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Show coordination of vibration isolation device installation for HVAC piping and equipment with other systems and equipment in the vicinity, including other supports and restraints, if any.

- B. Qualification Data: For testing agency.

PART 2 - PRODUCTS

2.01 ELASTOMERIC ISOLATION PADS

A. Elastomeric Isolation Pads: .

1. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
2. Size: Factory or field cut to match requirements of supported equipment.
3. Pad Material: Oil and water resistant with elastomeric properties.
4. Surface Pattern: Waffle pattern.
5. Infused nonwoven cotton or synthetic fibers.
6. Load-bearing metal plates adhered to pads.
7. Sandwich-Core Material: elastomeric.
 - a. Surface Pattern: Waffle pattern.
 - b. Infused nonwoven cotton or synthetic fibers.

2.02 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.

2.03 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.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine areas and equipment to receive vibration isolation control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 VIBRATION CONTROL DEVICE INSTALLATION

- A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 03 30 00 “Cast-in-Place Concrete.” Section 033053 “Miscellaneous Cast-in-Place Concrete.”
- B. Installation of vibration isolators must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.

END OF SECTION 23 05 48.13

SECTION 23 05 53
IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00.
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) requirements.

1.03 SUMMARY

- A. Section Includes:
 - 1. Equipment labels.
 - 2. Pipe labels.
 - 3. Stenciled labels
 - 4. Valve tags.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For color, letter style, and graphic representation required for each identification material and device.
- C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
- D. Valve numbering scheme.
- E. Valve Schedules: For each piping system to include in maintenance manuals.

PART 2 - PRODUCTS

2.01 EQUIPMENT LABELS

- A. 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. Letter Color: White.

3. Background Color: Black.
 4. Maximum Temperature: Able to withstand temperatures up to 160°F.
 5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
 6. 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.
 7. Fasteners: Stainless-steel self-tapping screws.
 8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- B. Label Content: Include equipment's Drawing designation or unique equipment number.
- C. 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.

2.02 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 partially cover 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; 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.

2.03 STENCILS

- A. Stencils for Fire Damper Access Panels:
 1. Lettering Size: Minimum letter height of 1/2 inch for viewing distances up to 72 inches and proportionately larger lettering for greater viewing distances.
 2. Stencil Material: Fiberboard or metal.

3. Stencil Paint: Exterior, gloss, alkyd enamel. Paint may be in pressurized spray-can form.
4. Identification Paint: Exterior, alkyd enamel. Paint may be in pressurized spray-can form.

2.04 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 minimum thickness, and having predrilled or stamped holes for attachment hardware.
 2. Fasteners: Brass 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. Valve-tag schedule shall be included in operation and maintenance data.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.02 GENERAL INSTALLATION REQUIREMENTS

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

3.03 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

3.04 PIPE LABEL INSTALLATION

- A. Pipe Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 1. Near each valve and control device.

2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 3. Near penetrations and on both sides of through walls, floors, ceilings, and inaccessible enclosures.
 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 5. Near major equipment items and other points of origination and termination.
 6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
 7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.
- B. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.
- C. Pipe Label Color Schedule:
1. Chilled-Water Piping: White letters on a safety-green background.
 2. Refrigerant Piping: Black letters on a safety-orange background.

3.05 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, shutoff valves, faucets, convenience and lawn-watering hose connections, and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.
- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:
1. Valve-Tag Size and Shape:
 - a. Chilled Water: 1-1/2 inches, round.
 - b. Refrigerant: 1-1/2 inches 2 inches, round.
 - c. Hot Water: 1-1/2 inches round.
 2. Valve-Tag Colors:
 - a. Potable and Other Water: White letters on a safety-green background.

END OF SECTION 23 05 53

SECTION 23 05 93
TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:

- 1. Balancing Air Systems:
 - a. Constant-volume air systems.
 - b. Variable-air-volume systems.
- 2. Balancing Hydronic Piping Systems:
 - a. Variable-flow hydronic systems.
- 3. Testing, Adjusting, and Balancing Equipment:
 - a. Motors.
 - b. Chillers.
 - c. Condensing units.
- 4. Testing, adjusting, and balancing existing systems and equipment.
- 5. Sound tests.
- 6. Vibration tests.
- 7. Duct leakage tests.
- 8. Control system verification.

1.03 DEFINITIONS

- A. AABC: Associated Air Balance Council.
- B. BAS: Building automation systems.
- C. NEBB: National Environmental Balancing Bureau.
- D. TAB: Testing, adjusting, and balancing.
- E. TABB: Testing, Adjusting, and Balancing Bureau.

- F. TAB Specialist: An independent entity meeting qualifications to perform TAB work.
- G. TDH: Total dynamic head.

1.04 INFORMATIONAL SUBMITTALS

- A. TAB firm;s qualifications, including:
 - 1. Certifications of the personnel that will be utilized on this project.
- B. 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.
- C. Contract Documents Examination Report: Within 30 days of Contractor's Notice to Proceed, submit the Contract Documents review report as specified in Part 3.
- D. Strategies and Procedures Plan: Within 60 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in “Preparation” Article.
- E. System Readiness Checklists: Within 30 days of Contractor's Notice to Proceed, submit system readiness checklists as specified in “Preparation” Article.
- F. Examination Report: Submit a summary report of the examination review required in “Examination” Article.
- G. Certified TAB reports.
- H. Sample report forms.
- I. 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.

1.05 QUALITY ASSURANCE

- A. TAB firm qualifications: A member for at least five years and in good standing with either AABC or NEBB.
 - 1. TAB Field Supervisor: Employee of the TAB specialist and certified by AABC or NEBB.
 - 2. TAB Technician: Employee of the TAB specialist and certified by AABC or NEBB as a TAB technician.
- B. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, “Instrumentation.”

- C. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 7.2.2 - “Air Balancing.”
- D. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.7.2.3 - “System Balancing.”

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.01 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. 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.

3.02 PREPARATION

- A. Prepare a TAB plan 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.

3.03 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance" or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and in this Section.
- B. 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. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Section 230713 "Duct Insulation," Section 230716 "HVAC Equipment Insulation," and Section 230719 "HVAC Piping Insulation."
- C. 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.
- D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.04 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 233113 "Metal Ducts."

3.05 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 Engineer of Record 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.

3.06 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

A. 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.

3.07 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.

3.08 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

- A. 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.
- B. 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.
- C. 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.
- D. 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.

3.09 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.

3.10 PROCEDURES FOR CHILLERS

A. Balance water flow through each evaporator to within specified tolerances of indicated flow with all pumps operating. With only one chiller operating in a multiple chiller installation, do not exceed the flow for the maximum tube velocity recommended by the chiller manufacturer. Measure and record the following data with each chiller operating at design conditions:

- 1. Evaporator-water entering and leaving temperatures, pressure drop, and water flow.
- 2. For water-cooled chillers, condenser-water entering and leaving temperatures, pressure drop, and water flow.
- 3. Evaporator and condenser refrigerant temperatures and pressures, using instruments furnished by chiller manufacturer.
- 4. Power factor if factory-installed instrumentation is furnished for measuring kilowatts.
- 5. Kilowatt input if factory-installed instrumentation is furnished for measuring kilowatts.
- 6. Capacity: Calculate in tons of cooling.

7. For air-cooled chillers, verify condenser-fan rotation and record fan and motor data including number of fans and entering- and leaving-air temperatures.

3.11 PROCEDURES FOR CONDENSING UNITS

- A. Verify proper rotation of fans.
- B. Measure entering- and leaving-air temperatures.
- C. Record fan and motor operating data.

3.12 SOUND TESTS

- A. After the systems are balanced and construction is Substantially Complete, measure and record sound levels at 5 locations as designated by the Architect-Engineer.
- B. Instrumentation:
 1. The sound-testing meter shall be a portable, general-purpose testing meter consisting of a microphone, processing unit, and readout.
 2. The sound-testing meter shall be capable of showing fluctuations at minimum and maximum levels, and measuring the equivalent continuous sound pressure level (LEQ).
 3. The sound-testing meter must be capable of using 1/3 octave band filters to measure mid-frequencies from 31.5 Hz to 8000 Hz.
 4. The accuracy of the sound-testing meter shall be plus or minus one decibel.
- C. Test Procedures:
 1. Perform test at quietest background noise period. Note cause of unpreventable sound that affects test outcome.
 2. Equipment should be operating at design values.
 3. Calibrate the sound-testing meter prior to taking measurements.
 4. Use a microphone suitable for the type of noise levels measured that is compatible with meter. Provide a windshield for outside or in-duct measurements.
 5. Record a set of background measurements in dBA and sound pressure levels in the eight un-weighted octave bands 63 Hz to 8000 Hz (NC) with the equipment off.
 6. Take sound readings in dBA and sound pressure levels in the eight un-weighted octave bands 63 Hz to 8000 Hz (NC) with the equipment operating.
 7. Take readings no closer than 36 inches from a wall or from the operating equipment and approximately 60 inches from the floor, with the meter held or mounted on a tripod.

8. For outdoor measurements, move sound-testing meter slowly and scan area that has the most exposure to noise source being tested. Use A-weighted scale for this type of reading.

D. Reporting:

1. Report shall record the following:
 - a. Location.
 - b. System tested.
 - c. dBA reading.
 - d. Sound pressure level in each octave band with equipment on and off.
2. Plot sound pressure levels on NC worksheet with equipment on and off.

3.13 VIBRATION TESTS

- A. After systems are balanced and construction is Substantially Complete, measure and record vibration levels on equipment having motor horsepower equal to or greater than 10.

B. Instrumentation:

1. Use portable, battery-operated, and microprocessor-controlled vibration meter with or without a built-in printer.
2. The meter shall automatically identify engineering units, filter bandwidth, amplitude, and frequency scale values.
3. The meter shall be able to measure machine vibration displacement in mils of deflection, velocity in inches per second, and acceleration in inches per second squared.
4. Verify calibration date is current for vibration meter before taking readings.

C. Test Procedures:

1. To ensure accurate readings, verify that accelerometer has a clean, flat surface and is mounted properly.
2. With the unit running, set up vibration meter in a safe, secure location. Connect transducer to meter with proper cables. Hold magnetic tip of transducer on top of the bearing, and measure unit in mils of deflection. Record measurement, then move transducer to the side of the bearing and record in mils of deflection. Record an axial reading in mils of deflection by holding nonmagnetic, pointed transducer tip on end of shaft.
3. Change vibration meter to velocity (inches per second) measurements. Repeat and record above measurements.
4. Record CPM or rpm.

5. Read each bearing on motor, fan, and pump as required. Track and record vibration levels from rotating component through casing to base.
- D. Reporting:
1. Report shall record location and the system tested.
 2. Include horizontal-vertical-axial measurements for tests.
 3. Verify that vibration limits follow Specifications, or, if not specified, follow the General Machinery Vibration Severity Chart or Vibration Acceleration General Severity Chart from the AABC National Standards. Acceptable levels of vibration are normally “smooth” to “good.”
 4. Include in report General Machinery Vibration Severity Chart, with conditions plotted.

3.14 DUCT LEAKAGE TESTS

- A. Witness the duct pressure testing performed by Installer.
- B. Verify that proper test methods are used and that leakage rates are within specified tolerances.
- C. Report deficiencies observed.

3.15 CONTROLS VERIFICATION

- A. 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.
- B. Reporting: Include a summary of verifications performed, remaining deficiencies, and variations from indicated conditions.

3.16 TOLERANCES

- A. 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. Cooling-Water Flow Rate: Plus or minus 10 percent.
- B. Maintaining pressure relationships as designed shall have priority over the tolerances specified above.

3.17 FINAL REPORT

- A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
 - 1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
 - 2. Include a list of instruments used for procedures, along with proof of calibration.
 - 3. Certify validity and accuracy of field data.
- B. 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.
- C. 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°F.
- e. Return-air, wet- and dry-bulb temperatures in°F.
- f. Entering-air, wet- and dry-bulb temperatures in°F.

- g. Leaving-air, wet- and dry-bulb temperatures in°F.
 - h. Water flow rate in gpm.
 - i. Water pressure differential in feet of head or psig.
 - j. Entering-water temperature in°F.
 - k. Leaving-water temperature in°F.
 - l. Refrigerant expansion valve and refrigerant types.
 - m. Refrigerant suction pressure in psig.
 - n. Refrigerant suction temperature in°F.
 - o. Inlet steam pressure in psig.
- G. Electric-Coil Test Reports: For electric furnaces, duct coils, and electric coils installed in central-station air-handling units, include the following:
- 1. Unit Data:
 - a. System identification.
 - b. Location.
 - c. Coil identification.
 - d. Capacity in Btu/h.
 - e. Number of stages.
 - f. Connected volts, phase, and hertz.
 - g. Rated amperage.
 - h. Airflow rate in cfm.
 - i. Face area in sq. ft..
 - j. Minimum face velocity in fpm.
 - 2. Test Data (Indicated and Actual Values):
 - a. Heat output in Btu/h.
 - b. Airflow rate in cfm.
 - c. Air velocity in fpm.
 - d. Entering-air temperature in°F.
 - e. Leaving-air temperature in°F.

- f. Voltage at each connection.
 - g. Amperage for each phase.
- H. 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.

- I. 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°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.
- J. 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°F.
- K. 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°F.
 - c. Leaving-water temperature in°F.
 - d. Water pressure drop in feet of head or psig.
 - e. Entering-air temperature in°F.
 - f. Leaving-air temperature in°F.
- L. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves and include the following:
- 1. Unit Data:
 - a. Unit identification.
 - b. Location.
 - c. Service.
 - d. Make and size.
 - e. Model number and serial number.
 - f. Water flow rate in gpm.

- g. Water pressure differential in feet of head or psig.
- h. Required net positive suction head in feet of head or psig.
- i. Pump rpm.
- j. Impeller diameter in inches.
- k. Motor make and frame size.
- l. Motor horsepower and rpm.
- m. Voltage at each connection.
- n. Amperage for each phase.
- o. Full-load amperage and service factor.
- p. Seal type.

2. Test Data (Indicated and Actual Values):

- a. Static head in feet of head or psig.
- b. Pump shutoff pressure in feet of head or psig.
- c. Actual impeller size in inches.
- d. Full-open flow rate in gpm.
- e. Full-open pressure in feet of head or psig.
- f. Final discharge pressure in feet of head or psig.
- g. Final suction pressure in feet of head or psig.
- h. Final total pressure in feet of head or psig.
- i. Final water flow rate in gpm.
- j. Voltage at each connection.
- k. Amperage for each phase.

M. Instrument Calibration Reports:

1. Report Data:

- a. Instrument type and make.
- b. Serial number.
- c. Application.
- d. Dates of use.

- e. Dates of calibration.

3.18 VERIFICATION OF TAB REPORT

- A. The TAB specialist's test and balance engineer shall conduct the inspection in the presence of commissioning authority.
- B. Commissioning authority 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, Owner 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, Architect-Engineer may contact AABC Headquarters regarding the AABC National Performance Guaranty.
- F. Prepare test and inspection reports.

3.19 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.

END OF SECTION 23 05 93

SECTION 23 07 13
DUCT INSULATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other related Specification sections, apply to this section.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00.
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) requirements.

1.03 SUMMARY

- A. Section includes insulating the following duct services:
 - 1. Indoor, concealed supply and outdoor air.
 - 2. Indoor, exposed supply and outdoor air.
 - 3. Indoor, concealed return located in unconditioned space.
 - 4. Indoor, exposed return located in unconditioned space.
 - 5. Indoor, concealed exhaust between isolation damper and penetration of building exterior.
 - 6. Indoor, exposed exhaust between isolation damper and penetration of building exterior.
 - 7. Outdoor, concealed supply and return.
 - 8. Outdoor, exposed supply and return.
- B. Related Sections:
 - 1. Section 23 07 16 “HVAC Equipment Insulation.”
 - 2. Section 23 07 19 “HVAC Piping Insulation.”

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied if any).
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail insulation application at elbows, fittings, dampers, specialties and flanges for each type of insulation.
3. Detail application of field-applied jackets.
4. Detail application at linkages of control devices.

1.05 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Field quality-control reports.

1.06 QUALITY ASSURANCE

- A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

PART 2 - PRODUCTS

2.01 INSULATION MATERIALS

- A. Comply with requirements in “Duct Insulation Schedule, General,” “Indoor Duct and Plenum Insulation Schedule,” and “Aboveground, Outdoor Duct and Plenum Insulation Schedule” articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

- F. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type II for sheet materials.

2.02 FIRE-RATED INSULATION SYSTEMS

- A. Fire-Rated Blanket: High-temperature, flexible, blanket insulation with FSK jacket that is tested and certified to provide a 2-hour fire rating by an NRTL acceptable to authorities having jurisdiction.

2.03 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.
- B. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
 - 1. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- C. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
 - 1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- D. PVC Jacket Adhesive: Compatible with PVC jacket.
 - 1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.04 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
 - 1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below ambient services.
 - 1. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
 - 2. Service Temperature Range: Minus 20 to plus 180°F.
 - 3. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
 - 4. Color: White.
- C. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.
 - 1. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.

2. Service Temperature Range: Minus 20 to plus 180°F.
3. Solids Content: 60 percent by volume and 66 percent by weight.
4. Color: White.

2.05 SEALANTS

A. FSK and Metal Jacket Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250°F.
4. Color: Aluminum.
5. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. ASJ Flashing Sealants, and Vinyl and PVC Jacket Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250°F.
4. Color: White.
5. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.06 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
4. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.
5. Vinyl Jacket: White vinyl with a permeance of 1.3 perms when tested according to ASTM E 96/E 96M, Procedure A, and complying with NFPA 90A and NFPA 90B.

2.07 FIELD-APPLIED FABRIC-REINFORCING MESH

- A. Woven Polyester Fabric: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in., in a Leno weave, for ducts.

2.08 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.
- C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
 - 1. Adhesive: As recommended by jacket material manufacturer.
 - 2. Color: White.
- D. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
 - 1. Sheet and roll stock ready for shop or field sizing.
 - 2. Finish and thickness are indicated in field-applied jacket schedules.
 - 3. Moisture Barrier for Indoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
 - 4. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
- E. Self-Adhesive Outdoor Jacket: 60-mil- thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a crosslaminated polyethylene film covered with white aluminum-foil facing.

2.09 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
 - 1. Width: 3 inches.
 - 2. Thickness: 11.5 mils.
 - 3. Adhesion: 90 ounces force/inch in width.
 - 4. Elongation: 2 percent.
 - 5. Tensile Strength: 40 lbf/inch in width.
 - 6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

- B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
 - 1. Width: 3 inches.
 - 2. Thickness: 6.5 mils.
 - 3. Adhesion: 90 ounces force/inch in width.
 - 4. Elongation: 2 percent.
 - 5. Tensile Strength: 40 lbf/inch in width.
 - 6. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.
- C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
 - 1. Width: 2 inches.
 - 2. Thickness: 6 mils.
 - 3. Adhesion: 64 ounces force/inch in width.
 - 4. Elongation: 500 percent.
 - 5. Tensile Strength: 18 lbf/inch in width.
- D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
 - 1. Width: 2 inches.
 - 2. Thickness: 3.7 mils.
 - 3. Adhesion: 100 ounces force/inch in width.
 - 4. Elongation: 5 percent.
 - 5. Tensile Strength: 34 lbf/inch in width.

2.10 SECUREMENTS

- A. Bands:
 - 1. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing seal or closed seal.
- B. Insulation Pins and Hangers:
 - 1. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

- a. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
 - b. Spindle: Aluminum or Stainless steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
 - c. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
2. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
- a. Baseplate: Perforated, nylon sheet, 0.030 inch thick by 1-1/2 inches in diameter.
 - b. Spindle: Nylon, 0.106-inch- diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches.
 - c. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
3. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
- a. Baseplate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
 - b. Spindle: Stainless steel, fully annealed, 0.106-inch- diameter shank, length to suit depth of insulation indicated.
 - c. Adhesive-backed base with a peel-off protective cover.
4. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick, stainless-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
- a. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.
5. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
- C. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.
- D. Wire: 0.062-inch soft-annealed, stainless steel.

2.11 CORNER ANGLES

- A. PVC Corner Angles: 30 mils thick, minimum 1 by 1 inch, PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.
- B. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch, aluminum according to ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
 - 1. Verify that systems to be insulated have been tested and are free of defects.
 - 2. Verify that surfaces to be insulated are clean and dry.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.03 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.
- B. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Keep insulation materials dry during application and finishing.
- G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- H. Install insulation with least number of joints practical.
- I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1. Install insulation continuously through hangers and around anchor attachments.

2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
- J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- K. Install insulation with factory-applied jackets as follows:
1. Draw jacket tight and smooth.
 2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
 - a. For below ambient services, apply vapor-barrier mastic over staples.
 4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.
- L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

3.04 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
1. Seal penetrations with flashing sealant.
 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.

3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
 4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
1. Seal penetrations with flashing sealant.
 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
 4. Seal jacket to wall flashing with flashing sealant.
- C. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- D. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.
1. Comply with requirements in Section 078413 “Penetration Firestopping” firestopping and fire-resistive joint sealers.
- E. Insulation Installation at Floor Penetrations:
1. Duct: For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches.
 2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 “Penetration Firestopping.”

3.05 INSTALLATION OF MINERAL-FIBER INSULATION

- A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
 2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
 3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

- a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
 - b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
 - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 - d. Do not overcompress insulation during installation.
 - e. Impale insulation over pins and attach speed washers.
 - f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
 - a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
 - b. Install vapor stops for ductwork and plenums operating below 50°F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.
 5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.
 6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
 7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.
- B. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.

2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
 - a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
 - b. On duct sides with dimensions larger than 18 inches, space pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
 - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 - d. Do not overcompress insulation during installation.
 - e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
 - a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
 - b. Install vapor stops for ductwork and plenums operating below 50°F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.
5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.06 FIELD-APPLIED JACKET INSTALLATION

- A. Where FSK jackets are indicated, install as follows:

1. Draw jacket material smooth and tight.
 2. Install lap or joint strips with same material as jacket.
 3. Secure jacket to insulation with manufacturer's recommended adhesive.
 4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch- wide joint strips at end joints.
 5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.
- B. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.
1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
- C. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

3.07 FIRE-RATED INSULATION SYSTEM INSTALLATION

- A. Where fire-rated insulation system is indicated, secure system to ducts and duct hangers and supports to maintain a continuous fire rating.
- B. Insulate duct access panels and doors to achieve same fire rating as duct.
- C. Install firestopping at penetrations through fire-rated assemblies. Fire-stop systems are specified in Section 078413 "Penetration Firestopping."

3.08 FINISHES

- A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."
 1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
 - a. Finish Coat Material: Interior, flat, latex-emulsion size.
- B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
- C. Color: Final color as selected by Architect-Engineer. Vary first and second coats to allow visual inspection of the completed Work.
- D. Do not field paint aluminum or stainless-steel jackets.

3.09 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 - 1. Inspect ductwork, randomly selected by Architect-Engineer, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each duct system defined in the “Duct Insulation Schedule, General” Article.
- C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.10 DUCT INSULATION SCHEDULE, GENERAL

- A. Plenums and Ducts Requiring Insulation:
 - 1. Indoor, concealed supply and outdoor air.
 - 2. Indoor, exposed supply and outdoor air.
 - 3. Indoor, concealed return located in unconditioned space.
 - 4. Indoor, exposed return located in unconditioned space.
 - 5. Indoor, concealed exhaust between isolation damper and penetration of building exterior.
 - 6. Indoor, exposed exhaust between isolation damper and penetration of building exterior.
 - 7. Outdoor, concealed supply and return.
 - 8. Outdoor, exposed supply and return.
- B. Items Not Insulated:
 - 1. Fibrous-glass ducts.
 - 2. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
 - 3. Factory-insulated flexible ducts.
 - 4. Factory-insulated plenums and casings.
 - 5. Flexible connectors.
 - 6. Vibration-control devices.
 - 7. Factory-insulated access panels and doors.

3.11 INDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Ducts and Plenums, Concealed:
 - 1. None.
- D. Ducts and Plenums, Exposed:
 - 1. None.

3.12 INDOOR DUCT INSULATION SCHEDULE

- A. Concealed single wall supply and return air duct insulation shall be the following:
 - 1. Mineral-Fiber Blanket: 1-1/2 inches thick and 1.5-lb/cu. ft. nominal density.
- B. Exposed single wall supply and return air duct insulation shall be the following:
 - 1. Mineral-Fiber Board: 1-1/2 inches thick and 2-lb/cu. ft. nominal density.

END OF SECTION 23 07 13

SECTION 23 07 16
HVAC EQUIPMENT INSULATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00.
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) requirements.

1.03 SUMMARY

- A. Section includes insulating the following HVAC equipment that is not factory insulated:
 - 1. Chilled-water pumps.
 - 2. Expansion/compression tanks.
 - 3. Air separators.
- B. Related Sections:
 - 1. Section 23 07 13 “Duct Insulation.”
 - 2. Section 23 07 19 “HVAC Piping Insulation.”

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied if any).
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
 - 2. Detail attachment and covering of heat tracing inside insulation.
 - 3. Detail removable insulation at equipment connections.
 - 4. Detail application of field-applied jackets.
 - 5. Detail application at linkages of control devices.
 - 6. Detail field application for each equipment type.

1.05 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.06 QUALITY ASSURANCE

- A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
 - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

PART 2 - PRODUCTS

2.01 INSULATION MATERIALS

- A. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- B. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- C. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- D. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- E. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 - 1. Block Insulation: ASTM C 552, Type I.
 - 2. Special-Shaped Insulation: ASTM C 552, Type III.
 - 3. Board Insulation: ASTM C 552, Type IV.
 - 4. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
- F. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.

- G. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. Provide insulation with factory-applied ASJ. Factory-applied jacket requirements are specified in “Factory-Applied Jackets” Article.

2.02 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.
- B. Cellular-Glass Adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100 to plus 200°F.
 - 1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- C. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
 - 1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- D. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
 - 1. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- E. Polystyrene Adhesive: Solvent- or water-based, synthetic resin adhesive with a service temperature range of minus 20 to plus 140°F.
- F. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
 - 1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- G. PVC Jacket Adhesive: Compatible with PVC jacket.
 - 1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.03 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
 - 1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.
 - 1. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.

2. Service Temperature Range: Minus 20 to plus 180°F.
 3. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
 4. Color: White.
- C. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.
1. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
 2. Service Temperature Range: Minus 20 to plus 180°F.
 3. Solids Content: 60 percent by volume and 66 percent by weight.
 4. Color: White.

2.04 SEALANTS

A. Joint Sealants:

1. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. FSK and Metal Jacket Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250°F.
4. Color: Aluminum.
5. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250°F.
4. Color: White.
5. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.05 FACTORY-APPLIED JACKETS

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
4. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.
5. PVDC Jacket for Indoor Applications: 4-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perm when tested according to ASTM E 96/E 96M and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.
6. PVDC Jacket for Outdoor Applications: 6-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perm when tested according to ASTM E 96/E 96M and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.
7. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.
8. Vinyl Jacket: White vinyl with a permeance of 1.3 perms when tested according to ASTM E 96/E 96M, Procedure A, and complying with NFPA 90A and NFPA 90B.

2.06 FIELD-APPLIED FABRIC-REINFORCING MESH

- A. Woven Polyester Fabric: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in., in a Leno weave, for equipment.

2.07 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.
- C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
 1. Adhesive: As recommended by jacket material manufacturer.
 2. Color: White.
 3. Factory-fabricated tank heads and tank side panels.
- D. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
 1. Sheet and roll stock ready for shop or field sizing.

2. Finish and thickness are indicated in field-applied jacket schedules.
3. Moisture Barrier for Indoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
4. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
 - a. Factory-Fabricated Fitting Covers:
 - b. Same material, finish, and thickness as jacket.
 - c. Preformed two-piece or gore, 45- and 90-degree, short- and long-radius elbows.
 - d. Tee covers.
 - e. Flange and union covers.
 - f. End caps.
 - g. Beveled collars.
 - h. Valve covers.
 - i. Field fabricate fitting covers only if factory-fabricated fitting covers are not available.
- E. Self-Adhesive Outdoor Jacket: 60-mil- thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a crosslaminated polyethylene film covered with white aluminum-foil facing.
- F. PVDC Jacket for Indoor Applications: 4-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perm when tested according to ASTM E 96/E 96M and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.
- G. PVDC Jacket for Outdoor Applications: 6-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perm when tested according to ASTM E 96/E 96M and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.
- H. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.

2.08 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
 1. Width: 3 inches.
 2. Thickness: 11.5 mils.

3. Adhesion: 90 ounces force/inch in width.
 4. Elongation: 2 percent.
 5. Tensile Strength: 40 lbf/inch in width.
 6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
1. Width: 3 inches.
 2. Thickness: 6.5 mils.
 3. Adhesion: 90 ounces force/inch in width.
 4. Elongation: 2 percent.
 5. Tensile Strength: 40 lbf/inch in width.
 6. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.
- C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
1. Width: 2 inches.
 2. Thickness: 6 mils.
 3. Adhesion: 64 ounces force/inch in width.
 4. Elongation: 500 percent.
 5. Tensile Strength: 18 lbf/inch in width.
- D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
1. Width: 2 inches.
 2. Thickness: 3.7 mils.
 3. Adhesion: 100 ounces force/inch in width.
 4. Elongation: 5 percent.
 5. Tensile Strength: 34 lbf/inch in width.
- E. PVDC Tape for Indoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.
1. Width: 3 inches.
 2. Film Thickness: 4 mils.

3. Adhesive Thickness: 1.5 mils.
 4. Elongation at Break: 145 percent.
 5. Tensile Strength: 55 lbf/inch in width.
- F. PVDC Tape for Outdoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.
1. Width: 3 inches.
 2. Film Thickness: 6 mils.
 3. Adhesive Thickness: 1.5 mils.
 4. Elongation at Break: 145 percent.
 5. Tensile Strength: 55 lbf/inch in width.

2.09 SECUREMENTS

- A. Bands:
1. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing seal or closed seal.
- B. Insulation Pins and Hangers:
1. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place.
 - a. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
 - b. Spindle: Aluminum, fully annealed, 0.106-inch- diameter shank, length to suit depth of insulation indicated.
 - c. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
 2. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place.
 - a. Baseplate: Perforated, nylon sheet, 0.030 inch thick by 1-1/2 inches in diameter.
 - b. Spindle: Nylon, 0.106-inch- diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches.

- c. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
- 3. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place.
 - a. Baseplate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
 - b. Spindle: Aluminum, fully annealed, 0.106-inch- diameter shank, length to suit depth of insulation indicated.
 - c. Adhesive-backed base with a peel-off protective cover.
- 4. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick, aluminum sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
 - a. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.
- 5. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
- C. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.
- D. Wire: 0.062-inch soft-annealed, stainless steel.

2.10 CORNER ANGLES

- A. PVC Corner Angles: 30 mils thick, minimum 1 by 1 inch, PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.
- B. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch, aluminum according to ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
 - 1. Verify that systems and equipment to be insulated have been tested and are free of defects.
 - 2. Verify that surfaces to be insulated are clean and dry.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:
 - 1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils thick and an epoxy finish 5 mils thick if operating in a temperature range between 140 and 300°F. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
 - 2. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300°F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
- B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
- C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.03 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Keep insulation materials dry during application and finishing.
- G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- H. Install insulation with least number of joints practical.
- I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1. Install insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.

3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
 4. Cover inserts with jacket material matching adjacent insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- K. Install insulation with factory-applied jackets as follows:
1. Draw jacket tight and smooth.
 2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
 - a. For below ambient services, apply vapor-barrier mastic over staples.
 4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints.
- L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- O. For above ambient services, do not install insulation to the following:
1. Vibration-control devices.
 2. Testing agency labels and stamps.
 3. Nameplates and data plates.
 4. Manholes.
 5. Handholes.
 6. Cleanouts.

3.04 INSTALLATION OF EQUIPMENT, TANK, AND VESSEL INSULATION

- A. Mineral-Fiber, Pipe and Tank Insulation Installation for Tanks and Vessels: Secure insulation with adhesive and anchor pins and speed washers.
1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of tank and vessel surfaces.
 2. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
 3. Protect exposed corners with secured corner angles.
 4. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:
 - a. Do not weld anchor pins to ASME-labeled pressure vessels.
 - b. Select insulation hangers and adhesive that are compatible with service temperature and with substrate.
 - c. On tanks and vessels, maximum anchor-pin spacing is 3 inches from insulation end joints, and 16 inches o.c. in both directions.
 - d. Do not overcompress insulation during installation.
 - e. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
 - f. Impale insulation over anchor pins and attach speed washers.
 - g. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
 5. Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.
 6. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch prestressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6 inches from each end. Install wire or cable between two circumferential girdles 12 inches o.c. Install a wire ring around each end and around outer periphery of center openings, and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches o.c. Use this network for securing insulation with tie wire or bands.
 7. Stagger joints between insulation layers at least 3 inches.

8. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.
 9. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
 10. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.
- B. Flexible Elastomeric Thermal Insulation Installation for Tanks and Vessels: Install insulation over entire surface of tanks and vessels.
1. Apply 100 percent coverage of adhesive to surface with manufacturer's recommended adhesive.
 2. Seal longitudinal seams and end joints.

3.05 FIELD-APPLIED JACKET INSTALLATION

- A. Where FSK jackets are indicated, install as follows:
1. Draw jacket material smooth and tight.
 2. Install lap or joint strips with same material as jacket.
 3. Secure jacket to insulation with manufacturer's recommended adhesive.
 4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch- wide joint strips at end joints.
 5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.
- B. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.
1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
- C. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.
- D. Where PVDC jackets are indicated, install as follows:
1. Jacket can be wrapped in cigarette fashion along length of roll for insulation systems with an outer circumference of 33-1/2 inches or less. 33-1/2-inch-circumference limit allows for 2-inch- overlap seal. Using the length of roll allows for longer sections of jacket to be installed at one time. Use adhesive on the lap seal. Visually inspect lap seal for "fishmouthing," and use PVDC tape along lap seal to secure joint.

2. Repair holes or tears in PVDC jacket by placing PVDC tape over the hole or tear and wrapping a minimum of 1-1/4 circumferences to avoid damage to tape edges.

3.06 FINISHES

- A. Equipment Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 09 91 13 "Exterior Painting" and Section 09 91 23 "Interior Painting."
 1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
 - a. Finish Coat Material: Interior, flat, latex-emulsion size.
- B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
- C. Color: Final color as selected by Architect-Engineer. Vary first and second coats to allow visual inspection of the completed Work.
- D. Do not field paint aluminum or stainless-steel jackets.

3.07 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections: Inspect field-insulated equipment, randomly selected by Architect-Engineer, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each type of equipment defined in the "Equipment Insulation Schedule" Article. For large equipment, remove only a portion adequate to determine compliance.
- C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.08 EQUIPMENT INSULATION SCHEDULE

- A. Insulation materials and thicknesses are identified below. If more than one material is listed for a type of equipment, selection from materials listed is Contractor's option.
- B. Insulate indoor and outdoor equipment that is not factory insulated.
- C. Chilled-water expansion/compression tank insulation shall be the following:
 1. Flexible Elastomeric: 1 inch thick.
- D. Chilled-water air-separator insulation shall be the following:
 1. Flexible Elastomeric: 1 inch thick.

3.09 INDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Equipment, Concealed:
 - 1. None.
- D. Equipment, Exposed, up to 48 Inches in Diameter or with Flat Surfaces up to 72 Inches:
 - 1. Aluminum, Smooth: 0.020 inch thick.

3.10 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Equipment, Exposed, up to 48 Inches in Diameter or with Flat Surfaces up to 72 Inches:
 - 1. Aluminum, Smooth with Z-Shaped Locking Seam: 0.020 inch thick.

END OF SECTION 23 07 16

SECTION 23 07 19
HVAC PIPING INSULATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00.
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) requirements.

1.03 SUMMARY

- A. Section includes insulating the following HVAC piping systems:
 - 1. Condensate drain piping.
 - 2. Chilled-water piping, indoors and outdoors.
 - 3. Refrigerant suction and hot-gas piping, indoors and outdoors.
- B. Related Sections:
 - 1. Section 23 07 13 “Duct Insulation.”
 - 2. Section 23 07 16 “HVAC Equipment Insulation.”

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied if any).
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
 - 2. Detail insulation application at pipe expansion joints for each type of insulation.
 - 3. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
 - 4. Detail removable insulation at piping specialties.
 - 5. Detail application of field-applied jackets.
 - 6. Detail application at linkages of control devices.

1.05 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.

1.06 QUALITY ASSURANCE

- A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
 - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.08 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 “Hangers and Supports for HVAC Piping and Equipment.”
- B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

PART 2 - PRODUCTS

2.01 INSULATION MATERIALS

- A. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- B. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- C. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- D. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- E. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in “Factory-Applied Jackets” Article.
 - 1. Block Insulation: ASTM C 552, Type I.

2. Special-Shaped Insulation: ASTM C 552, Type III.
 3. Board Insulation: ASTM C 552, Type IV.
 4. Preformed Pipe Insulation without Jacket: Comply with ASTM C 552, Type II, Class 1.
 5. Preformed Pipe Insulation with Factory-Applied ASJ: Comply with ASTM C 552, Type II, Class 2.
 6. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
- F. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.
- G. Mineral-Fiber, Preformed Pipe Insulation:
- H. Mineral-Fiber, Pipe Insulation Wicking System: Preformed pipe insulation complying with ASTM C 547, Type I, Grade A, with absorbent cloth factory-applied to the entire inside surface of preformed pipe insulation and extended through the longitudinal joint to outside surface of insulation under insulation jacket. Factory apply a white, polymer, vapor-retarder jacket with self-sealing adhesive tape seam and evaporation holes running continuously along the longitudinal seam, exposing the absorbent cloth.
- I. Polyolefin: Unicellular, polyethylene thermal plastic insulation. Comply with ASTM C 534 or ASTM C 1427, Type I, Grade 1 for tubular materials and Type II, Grade 1 for sheet materials.

2.02 INSULATING CEMENTS

- A. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449.

2.03 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.
- B. Cellular-Glass Adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100 to plus 200°F.
1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- C. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
- D. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
1. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- E. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

F. PVC Jacket Adhesive: Compatible with PVC jacket.

1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.04 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.

1. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
2. Service Temperature Range: Minus 20 to plus 180°F.
3. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
4. Color: White.

C. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.

1. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
2. Service Temperature Range: Minus 20 to plus 180°F.
3. Solids Content: 60 percent by volume and 66 percent by weight.
4. Color: White.

2.05 SEALANTS

A. Joint Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Permanently flexible, elastomeric sealant.
3. Service Temperature Range: Minus 100 to plus 300°F.
4. Color: White or gray.
5. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. FSK and Metal Jacket Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
 2. Fire- and water-resistant, flexible, elastomeric sealant.
 3. Service Temperature Range: Minus 40 to plus 250°F.
 4. Color: Aluminum.
 5. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
1. Materials shall be compatible with insulation materials, jackets, and substrates.
 2. Fire- and water-resistant, flexible, elastomeric sealant.
 3. Service Temperature Range: Minus 40 to plus 250°F.
 4. Color: White.
 5. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.06 FACTORY-APPLIED JACKETS

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
 2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
 3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
 4. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.
 5. PVDC Jacket for Indoor Applications: 4-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perm when tested according to ASTM E 96/E 96M and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.
 6. PVDC Jacket for Outdoor Applications: 6-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perm when tested according to ASTM E 96/E 96M and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.
 7. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.

8. Vinyl Jacket: White vinyl with a permeance of 1.3 perms when tested according to ASTM E 96/E 96M, Procedure A, and complying with NFPA 90A and NFPA 90B.

2.07 FIELD-APPLIED FABRIC-REINFORCING MESH

- A. Woven Polyester Fabric: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in., in a Leno weave, for pipe.

2.08 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.
- C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
 1. Adhesive: As recommended by jacket material manufacturer.
 2. Color: White.
 3. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
 - a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.
- D. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
 1. Sheet and roll stock ready for shop or field sizing.
 2. Finish and thickness are indicated in field-applied jacket schedules.
 3. Moisture Barrier for Indoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
 4. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
 5. Factory-Fabricated Fitting Covers:
 - a. Same material, finish, and thickness as jacket.
 - b. Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
 - c. Tee covers.
 - d. Flange and union covers.

- e. End caps.
 - f. Beveled collars.
 - g. Valve covers.
 - h. Field fabricate fitting covers only if factory-fabricated fitting covers are not available.
- E. Underground Direct-Buried Jacket: 125-mil- thick vapor barrier and waterproofing membrane consisting of a rubberized bituminous resin reinforced with a woven-glass fiber or polyester scrim and laminated aluminum foil.
 - F. Self-Adhesive Outdoor Jacket: 60-mil- thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a crosslaminated polyethylene film covered with white aluminum-foil facing.
 - G. PVDC Jacket for Indoor Applications: 4-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perms when tested according to ASTM E 96/E 96M and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.
 - H. PVDC Jacket for Outdoor Applications: 6-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perms when tested according to ASTM E 96/E 96M and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.
 - I. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.

2.09 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
 - 1. Width: 3 inches.
 - 2. Thickness: 11.5 mils.
 - 3. Adhesion: 90 ounces force/inch in width.
 - 4. Elongation: 2 percent.
 - 5. Tensile Strength: 40 lbf/inch in width.
 - 6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
 - 1. Width: 3 inches.
 - 2. Thickness: 6.5 mils.

3. Adhesion: 90 ounces force/inch in width.
 4. Elongation: 2 percent.
 5. Tensile Strength: 40 lbf/inch in width.
 6. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.
- C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
1. Width: 2 inches.
 2. Thickness: 6 mils.
 3. Adhesion: 64 ounces force/inch in width.
 4. Elongation: 500 percent.
 5. Tensile Strength: 18 lbf/inch in width.
- D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
1. Width: 2 inches.
 2. Thickness: 3.7 mils.
 3. Adhesion: 100 ounces force/inch in width.
 4. Elongation: 5 percent.
 5. Tensile Strength: 34 lbf/inch in width.
- E. PVDC Tape for Indoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.
1. Width: 3 inches.
 2. Film Thickness: 4 mils.
 3. Adhesive Thickness: 1.5 mils.
 4. Elongation at Break: 145 percent.
 5. Tensile Strength: 55 lbf/inch in width.
- F. PVDC Tape for Outdoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.
1. Width: 3 inches.
 2. Film Thickness: 6 mils.
 3. Adhesive Thickness: 1.5 mils.

4. Elongation at Break: 145 percent.
5. Tensile Strength: 55 lbf/inch in width.

2.10 SECUREMENTS

- A. Aluminum Bands: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing seal or closed seal.
- B. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.
- C. Wire: 0.062-inch soft-annealed, stainless steel.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
- C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.02 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during application and finishing.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.

- J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1. Install insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
 - 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- L. Install insulation with factory-applied jackets as follows:
 - 1. Draw jacket tight and smooth.
 - 2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
 - 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
 - a. For below-ambient services, apply vapor-barrier mastic over staples.
 - 4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
 - 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.
- M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- P. For above-ambient services, do not install insulation to the following:
 - 1. Vibration-control devices.

2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Manholes.
5. Handholes.
6. Cleanouts.

3.03 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
 1. Seal penetrations with flashing sealant.
 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
 4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.
- C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
 1. Seal penetrations with flashing sealant.
 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
 4. Seal jacket to wall flashing with flashing sealant.
- D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
 1. Comply with requirements in Section 078413 “Penetration Firestopping” for firestopping and fire-resistive joint sealers.

F. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.04 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.

8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
 9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.
- C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
- D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
 2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
 3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
 4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
 5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.05 INSTALLATION OF CELLULAR-GLASS INSULATION

- A. Insulation Installation on Straight Pipes and Tubes:
1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
 2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
 3. For insulation with factory-applied jackets on above-ambient services, secure laps with outward-clinched staples at 6 inches o.c.

4. For insulation with factory-applied jackets on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as pipe insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of cellular-glass insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

3.06 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

- A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.

4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- C. Insulation Installation on Pipe Fittings and Elbows:
1. Install mitered sections of pipe insulation.
 2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- D. Insulation Installation on Valves and Pipe Specialties:
1. Install preformed valve covers manufactured of same material as pipe insulation when available.
 2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 3. Install insulation to flanges as specified for flange insulation application.
 4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.07 INSTALLATION OF MINERAL-FIBER PREFORMED PIPE INSULATION

- A. Insulation Installation on Straight Pipes and Tubes:
1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
 2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
 3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward-clinched staples at 6 inches o.c.
 4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.
- B. Insulation Installation on Pipe Flanges:
1. Install preformed pipe insulation to outer diameter of pipe flange.
 2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.

3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
 4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.
- C. Insulation Installation on Pipe Fittings and Elbows:
1. Install preformed sections of same material as straight segments of pipe insulation when available.
 2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.
- D. Insulation Installation on Valves and Pipe Specialties:
1. Install preformed sections of same material as straight segments of pipe insulation when available.
 2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
 3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 4. Install insulation to flanges as specified for flange insulation application.

3.08 INSTALLATION OF POLYOLEFIN INSULATION

- A. Insulation Installation on Straight Pipes and Tubes:
1. Seal split-tube longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- B. Insulation Installation on Pipe Flanges:
1. Install pipe insulation to outer diameter of pipe flange.
 2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polyolefin sheet insulation of same thickness as pipe insulation.
 4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of polyolefin pipe insulation.
 2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- D. Insulation Installation on Valves and Pipe Specialties:
1. Install cut sections of polyolefin pipe and sheet insulation to valve body.
 2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 3. Install insulation to flanges as specified for flange insulation application.
 4. Secure insulation to valves and specialties, and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.09 FIELD-APPLIED JACKET INSTALLATION

- A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.
1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
 2. Embed glass cloth between two 0.062-inch- thick coats of lagging adhesive.
 3. Completely encapsulate insulation with coating, leaving no exposed insulation.
- B. Where FSK jackets are indicated, install as follows:
1. Draw jacket material smooth and tight.
 2. Install lap or joint strips with same material as jacket.
 3. Secure jacket to insulation with manufacturer's recommended adhesive.
 4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch- wide joint strips at end joints.
 5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.
- C. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications. Seal with manufacturer's recommended adhesive.
1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
- D. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

- E. Where PVDC jackets are indicated, install as follows:
1. Apply three separate wraps of filament tape per insulation section to secure pipe insulation to pipe prior to installation of PVDC jacket.
 2. Wrap factory-presizes jackets around individual pipe insulation sections with one end overlapping the previously installed sheet. Install presized jacket with an approximate overlap at butt joint of 2 inches over the previous section. Adhere lap seal using adhesive or SSL, and then apply 1-1/4 circumferences of appropriate PVDC tape around overlapped butt joint.
 3. Continuous jacket can be spiral-wrapped around a length of pipe insulation. Apply adhesive or PVDC tape at overlapped spiral edge. When electing to use adhesives, refer to manufacturer's written instructions for application of adhesives along this spiral edge to maintain a permanent bond.
 4. Jacket can be wrapped in cigarette fashion along length of roll for insulation systems with an outer circumference of 33-1/2 inches or less. The 33-1/2-inch-circumference limit allows for 2-inch- overlap seal. Using the length of roll allows for longer sections of jacket to be installed at one time. Use adhesive on the lap seal. Visually inspect lap seal for "fishmouthing," and use PVDC tape along lap seal to secure joint.
 5. Repair holes or tears in PVDC jacket by placing PVDC tape over the hole or tear and wrapping a minimum of 1-1/4 circumferences to avoid damage to tape edges.

3.10 FINISHES

- A. Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."
1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
 - a. Finish Coat Material: Interior, flat, latex-emulsion size.
- B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
- C. Color: Final color as selected by Architect-Engineer. Vary first and second coats to allow visual inspection of the completed Work.
- D. Do not field paint aluminum or stainless-steel jackets.

3.11 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
1. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect-Engineer, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of

straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the “Piping Insulation Schedule, General” Article.

- C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.12 PIPING INSULATION SCHEDULE, GENERAL

- A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.
- B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
 - 1. Drainage piping located in crawl spaces.
 - 2. Underground piping.
 - 3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.13 INDOOR PIPING INSULATION SCHEDULE

- A. Condensate and Equipment Drain Water below 60°F:
 - 1. All Pipe Sizes: Insulation shall be the following:
 - a. Flexible Elastomeric: 1 inch thick.
- B. Chilled Water, above 40°F:
 - 1. All Pipe Sizes: Insulation shall be the following:
 - a. Cellular Glass: 2 inches thick.
- C. Refrigerant Suction and Hot-Gas Piping:
 - 1. All Pipe Sizes: Insulation shall be the following:
 - a. Flexible Elastomeric: 1 inch thick.
- D. Refrigerant Suction and Hot-Gas Flexible Tubing:
 - 1. All Pipe Sizes: Insulation shall be the following:
 - a. Flexible Elastomeric: 1 inch thick.

3.14 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

- A. Chilled Water:
 - 1. All Pipe Sizes: Insulation shall be the following:
 - a. Cellular Glass: 3 inches thick.

- B. Refrigerant Suction and Hot-Gas Piping:
 - 1. All Pipe Sizes: Insulation shall be the following:
 - a. Flexible Elastomeric: 2 inches thick.
- C. Refrigerant Suction and Hot-Gas Flexible Tubing:
 - 1. All Pipe Sizes: Insulation shall be the following:
 - a. Flexible Elastomeric: 2 inches thick.

3.15 INDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Piping, Concealed:
 - 1. None.
- D. Piping, Exposed:
 - 1. None.

3.16 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Piping, Concealed:
 - 1. None.
- D. Piping, Exposed:
 - 1. Aluminum, Smooth 0.024 inch thick.

END OF SECTION 23 07 19

SECTION 23 08 00
COMMISSIONING OF HVAC

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section includes commissioning process requirements for the following HVAC&R systems, assemblies, and equipment:
 - 1. Cooling generation systems, including chilled-water systems and direct-expansion systems.
 - 2. Distribution systems, including air distribution (heating and cooling) systems, chilled-water distribution systems, exhaust systems, air-handling units.
 - 3. Terminal and packaged units, including fan-coil units, electric heating.
 - 4. Vibration and sound systems, including sound attenuation, vibration isolation devices.
 - 5. Controls and instrumentation, including BAS, energy monitoring and control system.
 - 6. Systems testing and balancing verification, including chilled-water piping systems supply-air systems return-air systems, exhaust-air systems.

1.03 DEFINITIONS

- A. BAS: Building automation system.
- B. DDC: Direct digital controls.
- C. HVAC&R: Heating, Ventilating, Air Conditioning, and Refrigeration.
- D. "Systems," "Subsystems," "Equipment," and "Components": Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.
- E. TAB: Testing, adjusting, and balancing.

1.04 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For BAS and HVAC&R Testing Technician.
- B. Construction Checklists: See related Sections for technical requirements for the following construction checklists:

1. Vibration controls for HVAC&R piping and equipment.
2. Instrumentation and control for HVAC&R.
3. Cooling-water piping and accessories.
4. Condensate piping and accessories.
5. Refrigerant piping.
6. Metal ducts and accessories.
7. Fans.
8. Air-handling units.
9. Computer-room air conditioners.
10. Chillers.
11. Pumps.

1.05 QUALITY ASSURANCE

- A. BAS Testing Technician Qualifications: Technicians to perform BAS construction checklist verification tests, construction checklist verification test demonstrations, commissioning tests, and commissioning test demonstrations shall have the following minimum qualifications:
 1. Journey-level or equivalent skill level with knowledge of BAS, HVAC&R, electrical concepts, and building operations.
 2. Minimum three years' experience installing, servicing, and operating systems manufactured by approved manufacturer.
 3. International Society of Automation (ISA) Certified Control Systems Technician (CCST) Level I.
- B. HVAC&R Testing Technician Qualifications: Technicians to perform HVAC&R construction checklist verification tests, construction checklist verification test demonstrations, commissioning tests, and commissioning test demonstrations shall have the following minimum qualifications:
 1. Journey-level or equivalent skill level. Vocational School four-year program graduate or an Associates degree in mechanical systems, air conditioning, or similar field. Degree may be offset by three years' experience in servicing mechanical systems in the HVAC industry. Generally, required knowledge includes HVAC&R systems, electrical concepts, building operations, and application and use of tools and instrumentation to measure performance of HVAC&R equipment, assemblies, and systems.
 2. Minimum three years' experience installing, servicing, and operating systems manufactured by approved manufacturer.

3. One of the following:
 - a. National Environmental Balancing Bureau (NEBB) Certified Testing, Adjusting, and Balancing Technician.
 - b. Associated Air Balance Council (AABC) Certified Test and Balance Technician.
 - c. Owner retains the right to waive NEBB or AABC Certification.

- C. Testing Equipment and Instrumentation Quality and Calibration: For test equipment and instrumentation required to perform HVAC&R commissioning work, perform the following:
 1. Submit test equipment and instrumentation list. For each equipment or instrument, identify the following:
 - a. Equipment/instrument identification number.
 - b. Planned commissioning application or use.
 - c. Manufacturer, make, model, and serial number.
 - d. Calibration history, including certificates from agencies that calibrate the equipment and instrumentation.

 2. Test equipment and instrumentation shall meet the following criteria:
 - a. Capable of testing and measuring performance within the specified acceptance criteria.
 - b. Be calibrated at the manufacturer's recommended intervals with current calibration tags permanently affixed to the instrument being used.
 - c. Be maintained in good repair and operating condition throughout the duration of use on this Project.
 - d. Be recalibrated/repared if dropped or damaged in any way since last calibrated.

- D. Proprietary Test Instrumentation and Tools:
 1. Equipment Manufacturer's Proprietary Instrumentation and Tools: For installed equipment included in the commissioning process, test instrumentation and tools manufactured or prescribed by equipment manufacturer to service, calibrate, adjust, repair, or otherwise work on its equipment or required as a condition of equipment warranty, perform the following:
 - a. Submit proprietary instrumentation and tools list. For each instrument or tool, identify the following:
 - 1) Instrument or tool identification number.
 - 2) Equipment schedule designation of equipment for which the instrument or tool is required.

- 3) Manufacturer, make, model, and serial number.
 - 4) Calibration history, including certificates from agencies that calibrate the instrument or tool, where appropriate.
- b. Include a separate list of proprietary test instrumentation and tools in the operation and maintenance manuals.
 - c. HVAC&R proprietary test instrumentation and tools become the property of Owner at the time of Substantial Completion.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.01 GENERAL TESTING REQUIREMENTS

- A. Certify that HVAC&R systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents and approved Shop Drawings and submittals.
- B. Certify that HVAC&R instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents and approved Shop Drawings and submittals, and that pretest set points have been recorded.
- C. Certify that TAB procedures have been completed and that TAB reports have been submitted, discrepancies corrected, and corrective work approved.
- D. Set systems, subsystems, and equipment into operating mode to be tested according to approved test procedures (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).
- E. Measure capacities and effectiveness of systems, assemblies, subsystems, equipment, and components, including operational and control functions to verify compliance with acceptance criteria.
- F. Test systems, assemblies, subsystems, equipment, and components operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and response according to acceptance criteria.
- G. Construction Checklists: Prepare and submit detailed construction checklists for HVAC&R systems, subsystems, equipment, and components.
 1. Contributors to the development of construction checklists shall include, but are not limited to, the following:
 - a. HVAC&R systems and equipment installers.
 - b. TAB technicians.
 - c. HVAC&R instrumentation and controls installers.
- H. Perform tests using design conditions, whenever possible.
 1. Simulated conditions may, with approval of Architect-Engineer, be imposed using an artificial load when it is impractical to test under design conditions. Before

simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by Commissioning Coordinator and document simulated conditions and methods of simulation. After tests, return configurations and settings to normal operating conditions.

2. Commissioning test procedures may direct that set points be altered when simulating conditions is impractical.
 3. Commissioning test procedures may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are impractical.
- I. If tests cannot be completed because of a deficiency outside the scope of the HVAC&R system, document the deficiency and report it to Owner. After deficiencies are resolved, reschedule tests.
 - J. If seasonal testing is specified, complete appropriate initial performance tests and documentation and schedule seasonal tests.
 - K. Coordinate schedule with, and perform the following activities at the direction of, Commissioning Coordinator.
 - L. Comply with construction checklist requirements, including material verification, installation checks, start-up, and performance tests requirements specified in Sections specifying HVAC systems and equipment.
 - M. Provide technicians, instrumentation, tools, and equipment to complete and document the following:
 1. Performance tests.
 2. Demonstration of a sample of performance tests.
 3. Commissioning tests.
 4. Commissioning test demonstrations.

3.02 TAB COMMISSIONING TESTS

- A. TAB Verification:
 1. Conditions of the Test:
 - a. Commissioning Test Demonstration Sampling Rate: As specified in “Inspections” Article in Section 230593 “Testing, Adjusting, and Balancing for HVAC.”
 - b. Systems operating in full heating mode with minimum outside-air volume.
 - c. Systems operating in full cooling mode with minimum outside-air volume.
 - d. For measurements at air-handling units with economizer controls; systems operating in economizer mode with 100 percent outside air.

2. Acceptance Criteria:
 - a. Under all conditions, rechecked measurements comply with “Inspections” Article in Section 230593 “Testing, Adjusting, and Balancing for HVAC.”
 - b. Additionally, no rechecked measurement shall differ from measurements documented in the final report by more than two times the tolerances allowed.
 - c. Under all conditions, where the Contract Documents indicate a differential in airflow between supply and exhaust and/or return in a space, the differential relationship shall be maintained.

3.03 CENTRAL REFRIGERATION SYSTEM COMMISSIONING TESTS

A. Start and Stop Chilled-Water Pump(s):

1. Prerequisites: Installation verification of the following:
 - a. Startup of chilled-water pump(s).
 - b. Input Device: Flow switch in chilled-water circuit.
 - c. Output Device: DDC system command to starter relay.
 - d. Display of the following at the operator's workstation:
 - 1) Chilled-water flow indication.
 - 2) Chilled-water pump(s) on-off status.
 - 3) Chilled-water pump(s) on-off indication.
2. Conditions of the Test:
 - a. Verify Start: Start with chilled-water pump enable-input device in the “disable” state to prevent pump start. Place the enable-input device in the “enable” state.
 - b. Verify Shutdown: Start with the enable-input device in the “enable” state to allow the pump(s) to run. Then place the enable-input device to the “disable” state.
3. Acceptance Criteria:
 - a. Start: Chilled-water pump(s) start when and only when the enable-input device is in the “enable” state.
 - b. Shutdown: The enable-input device stops the chilled-water pump(s) when placed in the “disable” state.

3.04 TERMINAL UNIT EQUIPMENT COMMISSIONING TESTS

A. Variable-Air-Volume Terminal Air Units:

1. Prerequisites: Installation verification of the following:

- a. Occupancy Input Device: Occupancy sensor.
- b. Occupancy Output Device: DDC system binary output.
- c. Room Temperature Input Device: Electronic temperature sensor.
- d. Room Temperature Output Device: Electronic damper actuators and control-valve operators.
- e. Display the following at the operator's workstation:
 - 1) Room/area served.
 - 2) Room occupied/unoccupied.
 - 3) Room temperature indication.
 - 4) Room temperature set point.
 - 5) Room temperature set point, occupied.
 - 6) Room temperature set point, unoccupied.
 - 7) Air-damper position as percentage open.
 - 8) Control-valve position as percentage open.

2. Conditions of the Test:

- a. Commissioning Test Demonstration Sampling Rate: 10 percent of each model/size unit.
- b. Temperature Control - Occupied: Start with the room unoccupied. Occupy the room and observe the change to occupied status. Observe temperature control until room temperature is stable at occupied set point plus or minus 1.0°F.
- c. Temperature Control - Unoccupied: Start with the room occupied. Vacate the room and observe the change to unoccupied status. Observe temperature control until room temperature is stable at unoccupied set point plus or minus 1.0°F.

3. Acceptance Criteria:

- a. Temperature Control - Occupied:
 - 1) Control system status changes from “occupied” to “unoccupied” after the specified time.
 - 2) Room temperature is stable at occupied set point plus or minus 1.0°F within 10 minutes of occupancy. Room temperature does not overshoot or undershoot set point by more than 2.0°F during transition.
- b. Temperature Control - Unoccupied:
 - 1) Control system status changes from “unoccupied” to “occupied” immediately.
 - 2) Room temperature is stable at unoccupied set point plus or minus 1.0°F within **30** minutes of occupancy.

3.05 AIR-HANDLING SYSTEM COMMISSIONING TESTS

A. Supply Fan(s) Variable-Volume Control:

1. Prerequisites: Installation verification of the following:
 - a. Volume Control Input Device: Static-pressure transmitter sensing supply-duct static pressure referenced to conditioned-space static pressure.
 - b. Volume Control Output Device: DDC system analog output to motor speed controller. Set variable-speed drive to minimum speed when fan is stopped.
 - c. High-Pressure Input Device: Static-pressure transmitter sensing supply-duct static pressure referenced to static pressure outside the duct.
 - d. High-Pressure Output Device: DDC system binary output to alarm panel.
 - e. Display the following at the operator's workstation:
 - 1) Supply-fan-discharge static-pressure indication.
 - 2) Supply-fan-discharge static-pressure set point.
 - 3) Supply-fan airflow rate.
 - 4) Supply-fan speed.
2. Conditions of the Test:
 - a. Minimum supply-air flow.
 - b. Midrange Supply-Air Flow: 50 to 60 percent of maximum.
 - c. Maximum supply-air flow.
 - d. Excess supply-air discharge static pressure.
3. Acceptance Criteria:
 - a. At all supply-air flow rates, and during changes in supply-air flow, discharge air static pressure is at set point plus or minus 2 percent.
 - b. Fan stops and an alarm is initiated at the operator's workstation when supply-air discharge static pressure is at the excess static pressure plus or minus 2 percent.

B. Air-Handler Mixed-Air Control:

1. Prerequisites: Installation verification of the following:
 - a. Minimum Position Input Device: DDC system time schedule.
 - b. Output Device: DDC system analog output to modulating damper actuator(s).
 - c. Supply-Air Temperature Input Device: Electronic temperature sensor.

- d. Cooling Reset Input Device: Outdoor- and return-air, duct-mounted electronic temperature sensors.
 - e. Display the following at the operator's workstation:
 - 1) Mixed-air-temperature indication.
 - 2) Mixed-air-temperature set point.
 - 3) Mixed-air damper position.
2. Conditions of the Test:
- a. Occupied Time Control: Start in unoccupied schedule. Advance to occupied schedule time.
 - b. Minimum Damper Position Control: Command system to mode in which minimum damper position is required.
 - c. Supply-Air Temperature Control: Override supply-air temperature set point to a value 2.0°F above current supply-air temperature.
 - d. Cooling Reset Control: Override outdoor-air temperature to a value that exceeds return-air temperature.
 - e. Unoccupied Time Control: Advance to unoccupied schedule time.
 - f. Control Data Trend Log: Set up a data trend log of the following input device values and output device commands. Record data at hourly intervals. Submit trend data for 24-hour periods in which natural conditions require heating reset control, supply-air temperature control, and cooling reset control.
 - 1) Minimum position input device.
 - 2) Heating reset input device.
 - 3) Supply-air temperature input device.
 - 4) Cooling reset input device.
3. Acceptance Criteria:
- a. Occupied Time Control: Mixed-air control is active in occupied mode.
 - b. Minimum Damper Position Control: Controller positions outdoor-air dampers to minimum position.
 - c. Supply-Air Temperature Control: Controller modulates outdoor-, return-, and relief-air dampers to maintain temporary supply-air temperature set point plus or minus 1.0°F.
 - d. Cooling Reset Control: Controller sets outdoor-air dampers to minimum position when outdoor-air temperature exceeds return-air temperature.
 - e. Unoccupied Time Control: Controller positions outdoor- and relief-air dampers closed and return-air dampers open.

- f. Control Data Trend Log: Data verifies control according to sequence of control.

END OF SECTION 23 08 00

SECTION 23 09 23
DIRECT DIGITAL CONTROL (DDC) SYSTEM FOR HVAC

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00.
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) requirements.

1.03 SUMMARY

- A. Section Includes:
 - 1. DDC system for monitoring and controlling of HVAC systems.
 - 2. Delivery of selected control devices to equipment and systems manufacturers for factory installation and to HVAC systems installers for field installation.
- B. Related Requirements:
 - 1. Section 23 09 23.33 “Control Valves”
 - 2. Section 23 09 23.43 “Control Dampers”
 - 3. Section 23 09 23.13 “Actuators and Operators”
 - 4. Section 23 09 23.23 ”Sensors and Transmitters”
 - 5. Section 28 13 00 “Access Control Software and Database Management”

1.04 CONTROLS INTEGRATION WITH MASTER CONTROLS SYSTEM

- A. This controls system shall be seamlessly integrated into and be subservient to the master building controls system. The master system will have other subservient systems integrated into it. The master system is specified in section 28 13 00 – Access Control Software and Database Management.
- B. Integration shall replicate system graphics presented in the HVAC DDC system.
- C. This division contractor shall work with master controls contractor / vendor as needed to facilitate the integration.
- D. Provide all required licensing and software needed for integration of this system into the master system.

- E. Coordinate tiered security access through the master system to permit access to the approved list of personnel with various skills sets.
- F. Programing and controls sequences specific to this division shall not be performed through the master system.

1.05 DEFINITIONS

- A. Algorithm: A logical procedure for solving a recurrent mathematical problem. A prescribed set of well-defined rules or processes for solving a problem in a finite number of steps.
- B. Analog: A continuously varying signal value, such as current, flow, pressure, or temperature.
- C. BACnet Specific Definitions:
 - 1. BACnet: Building Automation Control Network Protocol, ASHRAE 135. A communications protocol allowing devices to communicate data over and services over a network.
 - 2. BACnet Interoperability Building Blocks (BIBBs): BIBB defines a small portion of BACnet functionality that is needed to perform a particular task. BIBBs are combined to build the BACnet functional requirements for a device.
 - 3. BACnet/IP: Defines and allows using a reserved UDP socket to transmit BACnet messages over IP networks. A BACnet/IP network is a collection of one or more IP subnetworks that share the same BACnet network number.
 - 4. BACnet Testing Laboratories (BTL): Organization responsible for testing products for compliance with ASHRAE 135, operated under direction of BACnet International.
 - 5. PICS (Protocol Implementation Conformance Statement): Written document that identifies the particular options specified by BACnet that are implemented in a device.
- D. Binary: Two-state signal where a high signal level represents ON” or “OPEN” condition and a low signal level represents “OFF” or “CLOSED” condition. “Digital” is sometimes used interchangeably with “Binary” to indicate a two-state signal.
- E. Controller: Generic term for any standalone, microprocessor-based, digital controller residing on a network, used for local or global control. Three types of controllers are indicated: Network Controller, Programmable Application Controller, and Application-Specific Controller.
- F. Control System Integrator: An entity that assists in expansion of existing enterprise system and support of additional operator interfaces to I/O being added to existing enterprise system.
- G. COV: Changes of value.
- H. DDC System Provider: Authorized representative of, and trained by, DDC system manufacturer and responsible for execution of DDC system Work indicated.

- I. Distributed Control: Processing of system data is decentralized and control decisions are made at subsystem level. System operational programs and information are provided to remote subsystems and status is reported back. On loss of communication, subsystems shall be capable of operating in a standalone mode using the last best available data.
- J. DOCSIS: Data-Over Cable Service Interface Specifications.
- K. Gateway: Bidirectional protocol translator that connects control systems that use different communication protocols.
- L. HLC: Heavy load conditions.
- M. I/O: System through which information is received and transmitted. I/O refers to analog input (AI), binary input (BI), analog output (AO) and binary output (BO). Analog signals are continuous and represent control influences such as flow, level, moisture, pressure, and temperature. Binary signals convert electronic signals to digital pulses (values) and generally represent two-position operating and alarm status. "Digital," (DI and (DO), is sometimes used interchangeably with "Binary," (BI) and (BO), respectively.
- N. I/P: Current to pneumatic.
- O. LAN: Local area network.
- P. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.
- Q. Modbus TCP/IP: An open protocol for exchange of process data.
- R. MS/TP: Master-slave/token-passing, IEE 8802-3. Datalink protocol LAN option that uses twisted-pair wire for low-speed communication.
- S. MTBF: Mean time between failures.
- T. Network Controller: Digital controller, which supports a family of programmable application controllers and application-specific controllers, that communicates on peer-to-peer network for transmission of global data.
- U. Network Repeater: Device that receives data packet from one network and rebroadcasts it to another network. No routing information is added to protocol.
- V. PDA: Personal digital assistant.
- W. Peer to Peer: Networking architecture that treats all network stations as equivalent partners.
- X. POT: Portable operator's terminal.
- Y. PUE: Performance usage effectiveness.
- Z. RAM: Random access memory.
- AA. RF: Radio frequency.
- BB. Router: Device connecting two or more networks at network layer.

- CC. Server: Computer used to maintain system configuration, historical and programming database.
- DD. TCP/IP: Transport control protocol/Internet protocol incorporated into Microsoft Windows.
- EE. UPS: Uninterruptible power supply.
- FF. USB: Universal Serial Bus.
- GG. User Datagram Protocol (UDP): This protocol assumes that the IP is used as the underlying protocol.
- HH. VAV: Variable air volume.
- II. WLED: White light emitting diode.

1.06 REFERENCES

- A. All work shall conform to the following Codes and Standards, as applicable:
 - 1. National Fire Protection Association (NFPA) Standards
 - 2. National Electric Code (NEC) and applicable local Electric Code
 - 3. UL listing and labels
 - 4. UL 864 10th Edition UUKL Smoke Control (for USA and Canada)
 - 5. UL 268 Smoke Detectors
 - 6. UL 916 Energy Management
 - 7. NFPA 70 – National Electrical Code
 - 8. NFPA 90A – Standard For The Installation Of Air Conditioning And Ventilating Systems
 - 9. NFPA 92A and 92B Smoke Purge/Control Equipment
 - 10. Factory Mutual (FM)
 - 11. American National Standards Institute (ANSI)
 - 12. National Electric Manufacturer’s Association (NEMA)
 - 13. American Society of Mechanical Engineers (ASME)
 - 14. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE)
 - 15. Air Movement and Control Association (AMCA)
 - 16. Institute of Electrical and Electronic Engineers (IEEE)

17. American Standard Code for Information Interchange (ASCII)
18. Electronics Industries Association (EIA)
19. Occupational Safety and Health Administration (OSHA)
20. American Society for Testing and Materials (ASTM)
21. Federal Communications Commission (FCC) including Part 15, RF Devices
22. Americans Disability Act (ADA)
23. ANSI/EIA 909.1-A-1999 (LonWorks®)
24. ANSI/ASHRAE Standard 195 (BACnet)

1.07 DDC SYSTEM DESCRIPTION

- A. The DDC system shall be a complete system designed for use with the enterprise IT systems. This functionality shall extend into the equipment rooms. Devices residing on the automation network located in equipment rooms and similar shall be fully IT compatible devices that mount and communicate directly on the IT infrastructure in the facility. Contractor shall be responsible for coordination with the owner's IT staff to ensure that the DDC system will perform in the owner's environment without disruption to any of the other activities taking place on that LAN.
- B. Any and all components of the DDC system that are connected via field bus or IP network, including the network Controllers, equipment Controllers, application specific Controllers, server and user interface software, system and Controller programming tools and software applications shall be designed, engineered, and tested to work together as a complete building management system, and shall be manufactured by the same DDC system manufacturer.
- C. DDC System architecture shall support integration of third-party devices using industry accepted BACnet.
- D. All points of user interface shall be on standard computing devices that do not require the purchase of any special software from the DDC system manufacturer for use as a building operations terminal. The primary point of interface on these devices will be a standard Web Browser.
- E. Where necessary and as dictated elsewhere in these Specifications, Servers shall be used for the purpose of providing a location for extensive archiving of system configuration data, and historical data such as trend data and operator transactions.
- F. The work of the single DDC system Contractor shall be as defined individually and collectively in all Sections of this Division specification together with the associated Point Sheets and Drawings and the associated interfacing work as referenced in the related documents.
- G. The DDC system work shall consist of the provision of all labor, materials, tools, equipment, software, software licenses, software configurations and database entries, interfaces, wiring, tubing, installation, labeling, engineering, calibration, documentation, samples, submittals, testing, commissioning, training services, permits and licenses, transportation, shipping, handling, administration, supervision, management, insurance,

temporary protection, cleaning, cutting and patching, warranties, services, and items, even though these may not be specifically mentioned in these Division documents which are required for the complete, fully functional and commissioned DDC system.

H. The DDC system as provided shall incorporate, at minimum, the following integrated features, functions and services:

1. Operator information, alarm management and control functions
2. Information management including monitoring, transmission, archiving, retrieval, and reporting functions
3. Diagnostic monitoring and reporting of DDC system functions
4. Energy management
5. Standard applications for terminal HVAC systems
6. Enterprise-wide information and control access
7. Offsite monitoring and management access
8. Indoor Air Quality monitoring and control

1.08 QUALITY ASSURANCE

A. General

1. The contractor shall be a controls contractor who meets one of the following criteria:
 - a. The DDC system Contractor shall be a recognized national manufacturer, installer, and service provider of DDC system.
 - b. Purchases through an authorized DDC system distributor of the manufacturer and has been properly trained as an "Authorized Systems" contractor or installer through a qualified program supported and endorsed by the DDC system manufacturer. Proof of such shall be submitted prior to the award of any contract or notice to proceed.
2. DDC system Contractors whether having a direct or indirect authorized relationship with the DDC system manufacturer shall provide documentation that this relationship is current and in good standing with the DDC system manufacturer prior to any contracts being awarded. The DDC system Contractor shall also provide the name and contact information of the manufacturer's individual responsible for managing the distribution of their DDC system products, for the owner and/or engineer's benefit.
3. In order to protect the rights of the owner for future service, repairs, &/or additional work, the DDC system Contractor shall submit a letter from the DDC system manufacturer stating that they are not the "exclusive" representative of this manufacturer. The owner does not intend to be "locked in" to one representative. In order to provide the owner with the choice of who they do business with for work and/or services on this system after the scope of work detailed in this specification has been completed, any DDC system manufacturer

that provides "exclusive" geographic agreements with only one (1) DDC system Contractor or rep in this area, shall not be an acceptable.

4. The owner requires that there is at least three (3) DDC system Contractors servicing this geography that meet the above criteria for the DDC system Manufacturer in order for the manufacturer to be accepted.
5. The DDC system Contractor shall have a facility within a 100-mile radius of the job site supplying complete maintenance and support services on a 24 hour, 7-day-a-week basis. The DDC system Contractor shall have at this facility factory trained, directly employed and full-time technical staff, spare parts inventory, and all necessary test and diagnostic equipment.
6. As evidence and assurance of the DDC system Contractor's ability to support the owner's system with service and parts, the DDC system Contractor must have been in the DDC system business for at least the last five (5) years and have successfully completed at least 3 projects of comparable value of this contract in the preceding five years.
7. The Building Management System architecture shall consist of the products of a manufacturer regularly engaged in the production of Building Management Systems, and shall be the manufacturer's latest standard of design at the time of bid.

B. Workplace Safety and Hazardous Materials

1. Provide a safety program in compliance with the Contract Documents.
2. The DDC system Contractor shall have a corporately certified comprehensive Safety Certification Manual and a designated Safety Supervisor for the Project.
3. The Contractor and its employees and subtrades shall comply with federal, state and local safety regulations.
4. The Contractor shall ensure that all subcontractors and employees have written safety programs in place that covers their scope of work, and that their employees receive the training required by the OSHA rules that have jurisdiction for at least each topic listed in the Safety Certification Manual.
5. Hazards created by the Contractor or its subcontractors shall be eliminated before any further work proceeds.
6. Hazards observed but not created by the Contractor or its subcontractors shall be reported to either the General Contractor or the Owner within the same day. The Contractor shall be required to avoid the hazard area until the hazard has been eliminated.
7. The Contractor shall sign and date a safety certification form prior to any work being performed, stating that the Contractor's company is in full compliance with the Project safety requirements.
8. The Contractor's safety program shall include written policy and arrangements for the handling, storage and management of all hazardous materials to be used in the work in compliance with the requirements of the AHJ at the Project site.

- a. The Contractor’s employees and subcontractor’s staff shall have received training as applicable in the use of hazardous materials and shall govern their actions accordingly.

C. Quality Management Program

- 1. Designate a competent and experienced employee to provide DDC system Project Management. The designated Project Owner shall be empowered to make technical, scheduling and related decisions on behalf of the DDC system Contractor. At minimum, the Project Owner shall:
 - a. Manage the scheduling of the work to ensure that adequate materials, labor and other resources are available as needed.
 - b. Manage the financial aspects of the DDC system Contract.
 - c. Coordinate as necessary with other trades.
 - d. Be responsible for the work and actions of the DDC system workforce on site.

1.09 WORK BY OTHERS

- A. The demarcation of work and responsibilities between the DDC system Contractor and other related trades shall be as outlined in the DDC system RESPONSIBILITY MATRIX.

DDC SYSTEM RESPONSIBILITY MATRIX				
Work	Furnish	Install	Low Volt. Wiring/Tube	Line Power
DDC system low voltage and communication wiring *1 (note 1)	DDC system	DDC system	DDC system	N/A
VAV box Controller (note 2)	DDC system	23*2	DDC system	26
DDC system conduits and raceway	DDC system	DDC system	DDC system	DDC system
Automatic dampers (non-factory)	DDC system	23	N/A	N/A
Automatic valves	DDC system	23	DDC system	N/A
VAV boxes	23	23	N/A	N/A
Pipe insertion devices and taps including thermowells, flow and pressure stations.	DDC system	23	DDC system	DDC system
DDC system Current Switches.	DDC system	DDC system	DDC system	N/A
DDC system Control Relays	DDC system	DDC system	DDC system	N/A
Power distribution system monitoring interfaces	26	26	DDC system	26
Concrete and/or inertia equipment pads and seismic bracing	23	23	N/A	N/A
DDC system interface with Chiller controls	DDC system	DDC system	DDC system	DDC system
Chiller controls interface with DDC system	23	23	DDC system	26

DDC SYSTEM RESPONSIBILITY MATRIX				
Work	Furnish	Install	Low Volt. Wiring/Tube	Line Power
Elect. baseboard heating control (note 3)	23	26*3	N/A*3	26
ADD OTHER THIRD PARTY EQUIPMENT HERE	N/A	N/A	N/A	N/A
All DDC system Nodes, equipment, housings, enclosures and panels.	DDC system	DDC system	DDC system	DDC system
Smoke Detectors (note 4)	26	26	26/DDC system *4	26
Fire/Smoke Dampers (note 5)	23	23	DDC system*5	26
Fire Dampers	23	23	N/A	N/A
Chiller Flow Switches	23	23	DDC system	N/A
Boiler wiring	23	23	23	23
Water treatment system	23	23	23	26
VSDs	DDC system	26	DDC system	26
Refrigerant monitors	DDC system	DDC system	DDC system	26
Computer Room A/C Unit field-mounted controls	23	23	DDC system	26
Fire Alarm shutdown relay interlock wiring	26	26	26	26
Fire Alarm smoke control relay interlock wiring	26	26	DDC system	26
Fireman's Smoke Control Override Panel	26	26	26	26
Fan Coil Unit controls	DDC system	DDC system	DDC system	26
Cabinet/Unit Heater controls (note 6)	DDC system/23*6	26/DDC system*6	DDC system	26
Packaged RTU space mounted controls	23	DDC system	DDC system	26
Packaged RTU factory-mounted controls	23	23	DDC system	26
Packaged RTU field-mounted controls	DDC system	DDC system	DDC system	26
Cooling Tower Vibration Switches	23	23	26	26
Cooling Tower Level Control Devices	23	23	26	26
Cooling Tower makeup water control devices	23	23	26	26
Starters, HOA switches	26	26	N/A	26
Control damper actuators	DDC system	DDC system	DDC system	26

Footnotes:

- *1. DDC system low voltage and communications wiring: DDC system Ethernet communications cable and IP infrastructure furnish and install by DDC system Contractor or Division 26 Electrical Contractor as per options in Row #1 of the DDC system Responsibility Matrix above.
- *2. VAV box Controller factory installation would normally be by Division 23 Mechanical who furnishes the VAV boxes; could be by DDC system for field installation of special Controllers, see Row #2 of the DDC system Responsibility Matrix above.
- *3. Electric Baseboard Heating Controls – for line voltage stand-alone controls: furnished by Division 23 Mechanical Contractor who furnishes the baseboard units; line voltage controls installed and connected by Division 26 Electrical Contractor. Alternately, controls may be furnished and installed by DDC system Contractors for projects requiring Baseboard Heating controls to be integrated into the DDC system. Refer to Section 230993 SEQUENCE OF OPERATIONS.
- *4. Smoke Detector also wired to shut down AHU/HVAC by DDC system Contractor; Division 26 for projects NYC. Duct smoke detectors and fire alarm control modules shall be provided by others. Provide wiring, conduit, and necessary interface with fire alarm system to perform specified sequence of operation
- *5. Fire/Smoke Dampers: DDC system Contractor to provide and ensure OPEN/CLOSE control of Fire/Smoke dampers as coordinated between DDC system HVAC systems sequences, controls and overrides, and the Fire Alarm system control status priorities and overrides. Coordinate with Division 26 to provide duct detectors or fire alarm control modules for air handling unit and exhaust system shutdown and smoke control inputs to the DDC system. In most cases fire alarm control modules will be the most effective and flexible way of achieving this interface. Ensure that the logic matrix for the fire alarm devices to trigger a HVAC response is clearly specified.
- *6. Cabinet/Unit Heater Controls – for line voltage stand-alone controls: furnished by Division 23 Mechanical Contractor who furnishes the Cabinet/Unit Heaters; line voltage stand-alone controls installed and connected by Division 26 Electrical Contractor. Even for stand-alone controls, it is common for the line voltage TStat and associated interlock wiring to be installed by the BAS. The power to the UH/CUH is performed by the Division 26 contractor. Alternately, controls may be furnished and installed by DDC system Contractors for projects requiring Cabinet/Unit Heater controls to be integrated into DDC system. Refer to SEQUENCE OF OPERATIONS in the drawings.

1.10 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site .

1.11 SUBMITTALS

- A. Shop Drawings, Product Data, and Samples

- 1. The DDC system contractor shall submit a list of all shop drawings with submittals dates within 30 days of contract award.
- 2. Submittals shall be in defined packages. Each package shall be complete, shall only reference itself, and previously submitted packages. The packages shall be as approved by the Architect and Engineer for Contract compliance.
- 3. Allow 15 working days for the review of each package by the Architect and Engineer in the scheduling of the total DDC system work.
- 4. Equipment and systems requiring approval of local authorities must comply with such regulations and be approved. Filing shall be at the expense of the DDC system Contractor where filing is necessary. Provide a copy of all related correspondence and permits to the Owner.
- 5. Prepare an index of all submittals and shop drawings for the installation. Index shall include a shop drawing identification number, Contract Documents reference and item description.

6. The DDC system Contractor shall correct any errors or omissions noted in the first review.
7. At a minimum, submit the following:
 - a. DDC system network architecture diagrams including all nodes and interconnections
 - b. Systems schematics, sequences, and flow diagrams
 - c. Points schedule for each point in the DDC system, including: Point Type, Object Name, Expanded ID, Display Units, Controller type, and Address
 - d. Samples of Graphic Display screen types and associated menus
 - e. Detailed Bill of Material list for each system or application, identifying quantities, part numbers, descriptions, and optional features
 - f. Control Damper Schedule including a separate line for each damper provided under this section and a column for each of the damper attributes, including Code Number, Fail Position, Damper Type, Damper Operator, Duct Size, Damper Size, Mounting, and Actuator Type
 - g. Room Schedule including a separate line for each VAV box and/or terminal unit indicating location and address
 - h. Control Valve Schedules including a separate line for each valve provided under this section and a column for each of the valve attributes: Code Number, Configuration, Fail Position, Pipe Size, Valve Size, Body Configuration, Close off Pressure, Capacity, Valve CV, Design Pressure, and Actuator Type
 - i. Details of all DDC system interfaces and connections to the work of other trades
 - j. Product data sheets or marked catalog pages including part number, photo and description for all products including software

B. Existing Systems Inventory

1. Where applicable, provide a complete and current DDC system site inventory for all existing field and supervisory Controllers to be integrated into the new DDC system including manufacturer, model number, firmware version, available updates, battery condition, integrations, controlled equipment, and point counts.
2. Site inventory shall be provided on a separate, new USB compatible flash drive.

1.12 RECORD DOCUMENTATION

A. Operation and Maintenance Manuals.

1. Note: Item a. should be reviewed and edited as required. Visio or AutoCAD drawings are generally not provided unless specifically requested.

2. Three (3) copies of the Operation and Maintenance Manuals shall be provided to the Owner's Representative upon completion of the project. The entire Operation and Maintenance Manual shall be furnished on Compact Disc media or USB Flash Drive, and include the following for the DDC system provided:
 - a. Table of contents
 - b. As-built system record drawings. Computer Aided Drawings (CAD) record drawings shall represent the as-built condition of the system and incorporate all information supplied with the approved submittal.
 - c. Manufacturer's product data sheets or catalog pages for all products including software
 - d. System Operator's manuals
 - e. Archive copy of all site-specific databases and sequences
 - f. DDC system network diagrams
 - g. Interfaces to all third party products and work by other trades
- B. On-Line documentation: After completion of all tests and adjustments the contractor shall provide a copy of all as-built information and product data to be installed on a customer designated computer workstation or server.

1.13 WARRANTY

- A. Standard Material and Labor Warranty:
 1. Provide a one-year labor and material warranty on the DDC system.
 2. If within twelve (12) months from the date of acceptance of product, upon written notice from the owner, it is found to be defective in operation, workmanship or materials, it shall be replaced, repaired or adjusted at the option of the DDC system Contractor at the cost of the DDC system Contractor.
 3. Maintain an adequate supply of materials within 100 miles of the Project site such that replacement of key parts and labor support, including programming. Warranty work shall be done during DDC system Contractor's normal business hours.
 4. Maintenance of computer Software Programs: The DDC system Contractor shall maintain all software during the standard first year warranty period. In addition, all factory or sub-vendor upgrades to software during the first year warranty period shall be added to the systems, when they become available, at no additional cost. In addition to first year standard warranty, software provided by DDC system Contractor shall come with a 5 Year Software Maintenance license. All supervisory Controllers and BAS Servers are included in this coverage. Labor to implement upgrades in years two through five are not included in standard warranty.
 5. The Owner shall grant to DDC system Contractor reasonable access to the DDC system during the warranty period. Remote access to the DDC system (for the

purpose of diagnostics and troubleshooting, via the Internet, during the warranty period) will be allowed.

PART 2 - PRODUCTS

2.01 DDC SYSTEM DESCRIPTION

- A. The DDC system shall be a complete system designed for scalable implementation from small stand-alone use to large, networked systems. This functionality shall extend into the equipment rooms. Devices residing on the enterprise IT network shall be fully IT compatible devices that mount and communicate directly on the IT infrastructure in the facility. The contractor shall be responsible for coordination with the owner's IT staff to ensure that the BAS will perform in the owner's environment without disruption to any of the other activities taking place on that LAN.
- B. The DDC system shall consist of the following:
 - 1. Supervisory Controller(s), for managing networks of equipment Controllers and providing supervisory control services
 - 2. Programmable equipment Controllers, for directly operating and controlling mechanical equipment.
 - 3. Field bus network, for exchanging data between equipment Controllers and between equipment Controllers and supervisory Controllers
 - 4. Automation network, for exchanging data between supervisory Controllers, distributed user interface(s), and DDC system server.
 - 5. Distributed user interface(s), for providing operational access to the DDC system
 - 6. DDC system server, for managing networks of supervisory Controllers, equipment Controllers and providing additional supervisory control services.
 - 7. Local Display Device(s)
 - 8. Application software, for defining the sequence of operation of the DDC system.
 - 9. Other components required for a complete and working DDC system
- C. The system shall be modular in nature, and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, Controllers and operator devices, while re-using existing controls equipment.
- D. System architectural design shall eliminate dependence upon any single device for alarm reporting and control execution.
 - 1. The failure of any single component or network connection shall not interrupt the execution of control strategies at other operational devices.
 - 2. The System shall maintain all settings and overrides through a system reboot.
- E. Acceptable Manufacturers
 - 1. Johnson Controls, Facility Explorer

2.02 SUPERVISORY NETWORK CONTROLLER

A. General

1. The Supervisory Network Controller shall be a fully user-programmable, supervisory Controller. The Supervisory Network Controller shall monitor the network of equipment Controllers, provide global strategy and direction, and communicate on a peer-to-peer basis with other supervisory Controllers.
2. The Supervisory Network Controller shall also be a fully user-programmable, equipment Controller that includes a minimum of 28 I/O points.
3. Automation Network – The Supervisory Network Controller shall reside on the automation network and shall support a subnet system Controller.
4. User Interface – Each Supervisory Network Controller shall have the ability to deliver a web-based User Interface using the Site Management Portal functionality previously described. All computers connected physically or virtually to the automation network shall have access to the web-based user interface.
 - a. The web-based user interface software shall be embedded in the Supervisory Network Controller Systems that require a local copy of the system database on the user's device are not acceptable.
 - b. The Supervisory Network Controller shall support a minimum of two (2) concurrent users.
 - c. The web-based user interface shall have the capability to access all system data through a single Supervisory Network Controller.
 - d. Remote users connected to the network through a Virtual Private Network (VPN) shall also have total system access through one Supervisory Network Controller.
 - e. Systems that require the user to address more than one Supervisory Network Controller to access all system information are not acceptable.
 - f. The Supervisory Network Controller shall have the capability of serving web-based user interface graphics. The graphics capability shall be embedded in the Supervisory Network Controller
 - g. Systems that only support user interface graphics from a central database or require the graphics to reside on the user's device are not acceptable.
 - h. The web-based user interface shall support the following functions using a supported web browser:
 - 1) Configuration
 - 2) Commissioning
 - 3) Data Archiving
 - 4) Monitoring
 - 5) Commanding
 - 6) System Diagnostics

- i. Systems that require workstation software or modified web browsers are not acceptable.
5. Processor – The Supervisory Network Controller shall be microprocessor-based with a minimum word size of 32 bits. The Supervisory Network Controller shall be a multi-tasking, multi-user, and real-time digital control process. Standard operating systems shall be employed. Supervisory Network Controller size and capability shall be sufficient to fully meet the requirements of this Specification.
6. Memory – Each Supervisory Network Controller shall have sufficient memory to support its own operating system, databases, and control programs, and to provide supervisory control for all control level devices.
7. Secure Boot – The Supervisory Network Controller shall prevent malicious or unauthorized software applications from loading during the system startup process.
8. User Authentication – The Supervisory Network Controller shall support local user authentication.
9. Password Security – Access to the Supervisory Network Controller embedded user interface shall require a password of 8 to 50 characters including a minimum of one lower case letter, one upper case letter, one number, and one special character. An alarm shall be generated after three unsuccessful attempts within 15 minutes and the user shall be denied access until permission is renewed by a system administrator.
10. Network Security – Communication between the Supervisory Network Controller and other system networked devices shall be encrypted and support HTTPS with Transport Level Security (TLS) Version 1.2. Self-signed certificates are to be provided with the option of configuring trusted certificates.
11. Hardware Real Time Clock – The Supervisory Network Controller shall include an integrated, hardware-based, real-time clock, with a supercapacitor to maintain time for a minimum of 72 hours during a power loss. Controllers using a battery to maintain time during a power loss shall not be acceptable.
12. Diagnostics – The Supervisory Network Controller shall continuously perform self-diagnostics, communication diagnosis, and diagnosis of all panel components. The Supervisory Network Controller shall provide both local and remote annunciation of any detected component failures or repeated failures to establish communication.
13. Power Failure – In the event of the loss of normal power, the Supervisory Network Controller shall continue to operate for a user adjustable period of up to 10 minutes after which there shall be an orderly shutdown of all programs to prevent the loss of database or operating system software.
 - a. During a loss of normal power, the control sequences shall go to the normal system shutdown conditions. All critical configuration data shall be saved into Flash memory.
 - b. Upon restoration of normal power and after a minimum off-time delay, the Controller shall automatically resume full operation without manual intervention through a normal soft-start sequence.

14. Certification – The Supervisory Network Controller shall meet and be listed to the UL 916 Standard for Energy Management Equipment and be FCC Compliant to CFR47, Part 15, Subpart B, Class A.
15. Device Integration – The Supervisory Network Controller shall support integrating and supervising networked devices using the following communication protocols on the device/Controller network:
 - a. The Supervisory Network Controller shall support BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135 on the Controller network.
 - 1) The Supervisory Network Controller shall support Remote Field Bus integration via a BACnet IP to MS/TP router.
 - 2) The Supervisory Network Controller shall be tested and BTL listed/certified as a BACnet Building Controller (B-BC).
 - 3) A BACnet Protocol Implementation Conformance Statement shall be provided for the Supervisory Network Controller.
 - 4) The Protocol Implementation Conformance Statement shall be submitted 10 days prior to bidding.
16. The Supervisory Network Controller shall employ a finite state programming to eliminate unnecessary conflicts between control functions at crossover points in their operational sequences. Suppliers using non-state based DDC shall provide separate control strategy diagrams for all controlled functions in their submittals.
17. The Supervisory Network Controller shall be factory programmed with a continuous adaptive tuning algorithm that senses changes in the physical environment and continually adjusts loop tuning parameters appropriately. Controllers that require manual tuning of loops or perform automatic tuning on command only, shall not be acceptable.
18. The Supervisory Network Controller shall support the following types of inputs and outputs:
 - a. Universal Inputs – shall be configured to monitor any of the following:
 - 1) Analog Input, Voltage Mode
 - 2) Analog Input, Current Mode
 - 3) Analog Input, Resistive Mode
 - 4) Binary Input, Dry Contact Maintained Mode
 - 5) Binary Input, Pulse Counter Mode
 - b. Binary Inputs – shall be configured to monitor either of the following:
 - 1) Dry Contact Maintained Mode
 - 2) Pulse Counter Mode
 - c. Analog Outputs – shall be configured to output either of the following:
 - 1) Analog Output, Voltage Mode
 - 2) Analog Output, Current Mode
 - d. Binary Outputs – shall output the following:
 - 1) 24 VAC Triac

- e. Configurable Outputs – shall be configured to output either of the following:
 - 1) Analog Output, Voltage Mode
 - 2) Binary Output, 24 VAC Triac Mode

- 19. The Supervisory Network Controller shall have the ability to monitor and control a network of sensors and actuators over a Sensor Actuator (SA) Bus.
 - a. The SA Bus shall be a MS/TP Bus supporting BACnet Standard protocol SSPC-135.
 - b. The SA Bus shall support a minimum of 9 devices.
 - c. The SA Bus shall operate at a maximum distance of 1,200 Ft. between the Network Control Engine and the furthest connected device.

- 20. The Supervisory Network Controller shall have the capability to execute complex control sequences involving direct wired I/O points as well as input and output devices communicating over the Field Bus or the SA Bus.

- 21. The Supervisory Network Controller shall support, but not be limited to, the following applications:
 - a. Chilled water/central plant optimization applications including but not limited to:
 - 1) Selection and sequencing of up to three chillers of different sizes.
 - 2) Selection and sequencing of up to three variable primary chilled water pumps of varying pumping capacities.
 - 3) A proven and documented central cooling plant optimization program that incorporates custom equipment efficiency profiles, without rewriting software code, in order to meet the building load using the least amount of energy as calculated.
 - 4) The use of advanced control algorithms that apply equipment specific parameters, including operational limits and efficiency profiles, in order to determine equipment start and runtime preferences.
 - 5) Identification of the most efficient equipment combination and automatic control of state and speed of all necessary equipment to balance runtime, optimize timing and sequencing and ensure the efficiency and stability of the central cooling plant.
 - 6) Control definition for the chiller plant in a single Equipment Controller or Network Control Engine, as supported by available memory and point I/O, or capable of being split across multiple Equipment Controllers or Network Control Engines.
 - b. Lighting and electrical distribution.
 - c. Built-up air handling units for special applications.
 - d. Power generation and energy monitoring equipment.
 - e. Interfaces to security and fire detection systems.

22. The Supervisory Network Controller shall provide removable, labeled, screw terminal blocks for 24 VAC power, communication bus and I/O point field wiring.
23. The Supervisory Network Controller shall include the following multi-color, flashing LEDs to indicate important operating conditions and status:
 - a. Heartbeat – to indicate each of the following states: operational (normal), powered but not operational, starting up, shutting down, or no power applied
 - b. Fault – to indicate if fault conditions have been detected
 - c. SA Bus – to indicate if communication is occurring on the SA Bus
 - d. FC BUS-1 – to indicate if communication is occurring on FC Bus port 1
 - e. Ethernet Activity - to indicate if Ethernet Traffic is occurring or not occurring
 - f. USB-1|2 – to indicate if a supported device is connected, no device is connected, or an unsupported device is connected on USB port 1 or 2
 - g. FC EOL - to indicate if the end-of-line termination switch is on or off
24. Communications Ports – The Supervisory Network Controller shall provide the following ports for connecting networkable devices:
 - a. Two (2) USB ports
 - b. One (1) RS-485 port
 - c. Two (2) Ethernet ports
25. The Supervisory Network Controller shall support an integrated user interface featuring a display and keypad.
 - a. The integrated user interface shall allow viewing and monitoring points, alarms, and trends.
 - b. The integrated user interface shall allow viewing and changing setpoints, modes of operation, and parameters.
 - c. The integrated user interface shall provide password protection with user-adjustable password timeout.
 - d. The information presented by the integrated user interface shall be organized into folders for easy navigation.
 - e. The integrated user interface shall support textual descriptions in English for each point.
 - f. The display shall be, at minimum, a 2.4-inch, color display with 320x240 resolution.

- g. The display shall support adjustable contrast and brightness.
- h. The keypad shall include no more than seven (7) keys.

2.03 SUPERVISORY CONTROLLER(S)

- A. Supervisory Controller(s) shall provide network management services between itself and the equipment Controllers which are connected to its communications trunks, between itself and other supervisory Controllers, and between itself and any user interface clients that are part of the DDC system.
- B. Supervisory Controller(s) shall be enabled to support and shall be licensed with the BACnet open protocol drivers (client and server) by default.
- C. Supervisory Controller(s) shall perform control and operating strategies for the system based on information from any equipment Controller connected to the DDC system, including but not limited to the following:
 - 1. Scheduling, including calendar functions
 - 2. Historical data collection, management, and visualization
 - 3. Alarm initiation, routing, and notification
 - 4. Time synchronization
 - 5. Managing the exchange of data between itself and equipment Controllers
 - 6. Closed loop control and interlocking
- D. Supervisory Controllers shall be capable of peer-to-peer communications with other supervisory Controllers and with any user interface client connected to the DDC system, whether the user interface client is directly connected, connected via cellular modem or connected via the Intranet or Internet.
- E. The communication protocols utilized for peer-to-peer communications between supervisory Controllers shall be Niagara 4 Fox, BACnet TCP/IP or SNMP. Use of a different communication protocol for peer-to-peer communications between supervisory Controllers is not allowed.
- F. The supervisory Controller(s) shall employ a device count capacity license model that supports expansion capabilities.
- G. The supervisory Controller(s) shall provide the following hardware features as a minimum:
 - 1. Two 10/100 Mbps Ethernet ports.
 - 2. Two isolated RS-485 ports with biasing switches.
 - 3. 1 GB RAM
 - 4. 4 GB Flash Total Storage / 2 GB user storage
 - 5. Wi-Fi (Client or WAP)

6. USB flash drive
 7. High speed field bus expansion
 8. -20-60 degrees C ambient operating temperature
 9. Integrated 24 VAC/DC global power supply
 10. MicroSD memory card employing Encrypted Safe Boot Technology
- H. The supervisory Controller(s) shall include an embedded web server to support standard web browser access via the Intranet/Internet. It shall support a minimum of 16 simultaneous users.
- I. The supervisory Controller(s) shall provide alarm generation, storage, routing, management and analysis to data sourced from equipment Controllers, network thermostats, and direct field inputs, including the following capabilities:
1. Alarming capability shall support being added to any data point in the supervisory Controller's database.
 2. User-defined criteria shall be used to define when the point meets an alarm condition (is in an alarmed state), including, but not limited to the following:
 - a. For numeric-type data points: when the data point's value falls outside a user-defined range.
 - b. For Boolean or enumerated type data points: when the data point's state matches a user defined alarm state.
 - c. For string-type data points, when the data point's string text includes or excludes a user-defined string text.
 - d. For commanded points, when the data point's actual value does not match its commanded value after an appropriate (user-defined) time delay.
 3. Alarm generation shall be selectable for annunciation type and acknowledgement requirements, including but not limited to:
 - a. To alarm.
 - b. Return to normal.
 - c. To default.
 4. Each alarm record shall include at a minimum, the following information:
 - a. Name of source data point
 - b. Time and date of alarm occurrence
 - c. Acknowledge time, date, and user who issued acknowledgement

5. Routing of alarms shall be user-defined, and may include one or more of the following destinations:
 - a. A dynamically-updated alarm console on the distributed user interface screen.
 - b. A bound, animated symbol on the distributed user interface screen.
 - c. Email
 - d. Pagers, using paging services that initiate a page-on receipt of email message.
 - e. SMS text message
 - f. Line printer
 - g. Another supervisory Controller or a DDC system Server for alarm centralization and/or archival
 6. Alarms that have gone unacknowledged by the specified contact for a specified time shall re-routed to the next specified contact.
 7. Alarms shall support customized text instructions to be assigned to them, so that any time an alarm is generated, the instructions are included and presented along with the alarm notification to guide the operator on how to recover from the alarm condition.
 8. Authorized operators shall be allowed (and optionally required) to add a note to one or more alarm records simultaneously to provide historical context for the event that triggered the alarm.
 9. Authorized operators shall be allowed to acknowledge alarms using the alarm console on the user interface.
 10. Authorized operators shall be allowed to silence the audible alarm sound on the alarm console.
 11. Authorized operators shall be allowed to delete alarm records from the alarm database but only after the alarms have been acknowledged and the source data point is in a normal (no longer in alarm) state.
- J. The supervisory Controller(s) shall support the following security functions to prevent unauthorized access:
1. The supervisory Controller(s) shall use module code signing to verify the author of programming tool and confirm that the code has not been altered or corrupted.
 2. The supervisory Controller(s) shall use Role-Based Access Control (RBAC) for managing user roles and permissions.
 3. The supervisory Controller(s) shall require strong user passwords.
 4. All data in motion and sensitive data at rest in the supervisory Controller(s) shall be encrypted.

5. The supervisory Controller(s) shall support LDAP and Kerberos integration of access management.
- K. The supervisory Controller(s) shall support tagging to utilize Search, Hierarchy, and User Permission functionality.
- L. The supervisory Controller(s) shall provide scheduling capabilities being added to any writable data point in the supervisory Controller's database, sourced from any equipment Controllers, network thermostats, and direct field inputs, including the following capabilities:
1. The supervisory Controller(s) shall support scheduling on a weekly and special event basis.
 2. Authorized operators shall be allowed to view and adjust the exact start/stop time and dates for the weekly schedule and special events from the user interface.
 3. The supervisory Controller(s) shall support sharing schedule configurations with other supervisory Controller(s), with the DDC system server, and with scheduling-enabled BACnet devices.
- M. The supervisory Controller(s) shall support data logging capabilities being added to any data point in the supervisory Controller's database, sourced from any equipment Controllers, network thermostats, and direct field inputs, including the following capabilities:
1. Data logs shall be organized into ordered collections of timestamped records, herein called histories.
 2. Each history record shall include at a minimum, the following information:
 - a. History name
 - b. Data point value
 - c. Time and date when data point was logged
 3. User-defined criteria shall be used to define when the data point is logged, including, but not limited to the following:
 - a. When the data point's value, state, or string changes by a user-defined amount.
 - b. At a regular, repeating, user-defined time intervals.
 4. The supervisory Controller shall support user-specified local storage capacity for the history records. The data logging behavior upon reaching the specified capacity shall be user-selectable from the following options:
 - a. Stop: terminate recording.
 - b. Roll: overwrite older records with newer ones.
 5. Histories shall support being viewed by operators in a table or chart format on the user interface.

6. The supervisory Controller shall support the automatic exporting of one or more histories to the DDC system server for long term archival.
- N. The supervisory Controller's configuration software shall be embedded into the supervisory Controller, enabling an authorized user to access the configuration software using a web browser.
- O. The supervisory Controller shall be provided with a 5-year software maintenance license. Labor to implement not included.

2.04 DDC EQUIPMENT CONTROLLERS

A. General Purpose Equipment Controller (CGM and CGE Controllers)

1. The General Purpose Equipment Controller shall be a fully programmable, digital Controller. The Controller communicates via the BACnet MS/TP protocol. The CGE Controller communicates via the BACnet/IP protocol.
 - a. The shall support BACnet Standard ANSI/ASHRAE 135.
 - b. The Controller shall be BTL listed/certified.
 - c. The Controller shall be tested and certified as a BACnet Advanced Application Controller (B-AAC).
 - d. A BACnet Protocol Implementation Conformance Statement shall be provided for the Controller.
 - e. The Conformance Statement shall be submitted 10 days prior to bidding.
2. The Controller shall employ finite state programming to eliminate unnecessary conflicts between control functions at crossover points in their operational sequences. Suppliers using non-state based DDC shall provide separate control strategy diagrams for all controlled functions in their submittals.
3. The Controllers shall be factory programmed with a continuous adaptive tuning algorithm that senses changes in the physical environment and continually adjusts loop tuning parameters appropriately. Controllers that require manual tuning of loops or perform automatic tuning on command only shall not be acceptable.
4. The Controller shall be assembled in a plastic housing with protection class IP20 (IEC529) and flammability rated to UL94-5VB.
5. The Controller shall include an integral real-time clock and support time-based tasks which enables these equipment Controllers to monitor and control:
 - a. Schedules
 - b. Calendars
 - c. Alarms
 - d. Trends

6. The controller can continue time-based monitoring when offline for extended periods of time from a network.
7. The controller can operate as a stand-alone Controller in applications that do not require a networked supervisory device or for network applications where it is preferred to have the scheduling, alarming, and/or trending performed locally in the equipment Controllers.
8. The controller shall include troubleshooting LEDs to indicate the following conditions:
 - a. Power—to indicate if the Controller is powered or not powered
 - b. Fault – to indicate if the Controller is in its default state, has no faults, has a device fault, is in startup or download mode, or has an SA Bus communication issue
 - c. SA Bus – to indicate if SA Bus communication is occurring and normal, is not occurring, or was occurring but has been lost and is waiting to rejoin
 - d. FC Bus – to indicate if FC Bus communication is occurring and normal, is not occurring, or was occurring but has been lost and is waiting to rejoin
 - e. EOL – to indicate if the end-of-line termination switch is on or off
9. The controller shall include troubleshooting LEDs to indicate the following conditions:
 - a. Power—to indicate if the Controller is powered or not powered
 - b. Fault– to indicate if the Controller is in its default state, has no faults, has a device fault, is in startup or download mode, or has an SA Bus communication issue
 - c. SA Bus - to indicate if SA Bus communication is occurring and normal, is not occurring, or was occurring but has been lost and is waiting to rejoin
 - d. ETH-1 - to indicate if the Controller is connected and communicating, or is not connected
 - e. ETH-2- to indicate if the Controller is connected and communicating, or is not connected
10. The controller shall have the ability to transfer and apply firmware files to all SA Bus devices (XPM, PCX, and NS8000) connected to it.
11. The controller shall include pluggable screw terminal blocks for all I/O, SA Bus communication, and power wiring connections. The CGM shall also include a pluggable screw terminal block for FC bus communication.
12. The controller shall accommodate the direct wiring of analog and binary I/O field points with the following resolution.

- a. Inputs – 24-bit analog-to-digital converter
 - b. Outputs – +/- 200 mV accuracy in 0-10 VDC applications
13. The CONTROLLER shall support the following types of inputs and outputs supplied in the amounts required for the specified applications:
- a. Universal Inputs – shall be configurable to monitor any of the following:
 - 1) 0-10 VDC analog input
 - 2) 4-20 mA analog input
 - 3) 0-600k ohms analog input
 - 4) Dry contact binary input
 - b. Binary Inputs – shall be configurable to monitor either of the following:
 - 1) Dry Contact Maintained Mode
 - 2) Pulse Counter Mode
 - c. Analog Outputs – shall be configurable to output either of the following:
 - 1) 0-10 VDC analog output
 - 2) 4-20 mA analog output
 - d. Binary Outputs – shall output the following:
 - 1) 24 VAC Triac
 - e. Configurable Outputs – shall be capable of the following:
 - 1) 0-10 VDC analog output
 - 2) 24 VAC Triac binary output
14. The CGM shall have the ability to reside on a Field Controller Bus (FC Bus).
- a. The FC Bus shall be a MS/TP Bus supporting BACnet Standard protocol SSPC-135.
 - b. The FC Bus shall support communications between the CGMs and the supervisory Controller.
 - c. The FC Bus shall also support peer-to-peer communications between non-supervisory devices, allowing these devices to communicate system data with each other directly, bypassing the supervisory Controllers on the bus.
 - d. The FC Bus shall support a minimum of 100 equipment Controllers and/or expansion modules in any combination.
 - e. The FC Bus shall operate at a maximum distance of 15,000 Ft. between the CGM and the furthest connected device.
15. The CGE shall have the ability to reside on the Automation Network with the following capabilities

- a. The CGE shall communicate with Open Data Servers (BACnet listed OWS) and Network Engines.
 - b. The CGE shall support BACnet IPv4
 - c. The CGE shall support Peer to Peer communications with other Controllers on the automation network.
16. The controller shall include three (3) decimal rotary dial switches for setting the BACnet MS/TP device address.
 17. The controller shall include three (3) decimal rotary dial switches for setting the controller number.
 18. The controller shall have the ability to monitor and control a network of sensors and actuators over a SA Bus.
 - a. The SA Bus shall be a MS/TP Bus supporting BACnet Standard Protocol SSPC-135.
 - b. The SA Bus shall support a minimum of 10 devices per trunk.
 - c. The SA Bus shall operate at a maximum distance of 1,200 Ft. between the controller and the furthest connected device.
 19. The controller shall have the capability to execute complex control sequences involving direct wired I/O points as well as input and output devices communicating over a MS/TP Bus.
 20. The controller shall support, but not be limited to, the following applications.
 - a. Chilled water/central plant optimization applications including but not limited to:
 - 1) Selection and sequencing of up to three chillers of different sizes.
 - 2) Selection and sequencing of up to three variable primary chilled water pumps of varying pumping capacities.
 - 3) A proven and documented central cooling plant optimization program that incorporates custom equipment efficiency profiles, without rewriting software code, in order to meet the building load using the least amount of energy as calculated.
 - 4) The use of advanced control algorithms that apply equipment specific parameters, including operational limits and efficiency profiles, in order to determine equipment start and runtime preferences.
 - 5) Identification of the most efficient equipment combination and automatic control of state and speed of all necessary equipment to balance runtime, optimize timing and sequencing and ensure the efficiency and stability of the central cooling plant.
 - 6) Control definition for the chiller plant in a single CGM, CGEs, PCA, or supervisory Controller, as supported by available memory and point I/O, or capable of being split across multiple CGMs, CGEs, PCAs, or supervisory Controllers.

- b. Heating central plant applications.
 - c. Built-up air handling units for special applications.
 - d. Terminal & package units.
 - e. Special programs as required for systems control.
21. The controller shall support a Local Controller Display as a remote device communicating over the SA Bus.
- a. The Display shall use a BACnet Standard SSPC-135 MS/TP protocol.
 - b. The Display shall allow the user to view monitored points without logging into the system.
 - c. The Display shall allow the user to view and change setpoints, modes of operation, and parameters.
 - d. The Display shall provide password protection with user adjustable password timeout.
 - e. The Display shall be menu driven with separate paths for:
 - 1) Input/Output
 - 2) Parameter/Setpoint
 - 3) Overrides
 - f. The Display shall use easy-to-read English text messages.
 - g. The Display shall allow the user to select the points to be shown and in what order.
 - h. The Display shall support a back lit LCD with adjustable contrast and brightens and automatic backlight brightening during user interaction.
 - i. The display shall be a minimum of 4 lines and a minimum of 20 characters per line.
 - j. The Display shall have a keypad with no more than 7 keys.
 - k. The Display shall be panel mountable.
22. Provide controller or approved equivalent as shown on plans.
23. Equipment Controllers shall be programmed using the ASHRAE Guideline 36: High-Performance Sequences of Operation for HVAC Systems

B. VAV Box Controller (Controllers)

- 1. The VAV Box Controller shall provide both standalone and networked DDC of pressure-independent, VAV terminal units.
- 2. The VAV Box Controller shall be a fully programmable, digital Controller that communicates via BACnet MS/TP protocol.

- a. The controller shall support BACnet Standard ANSI/ASHRAE 135.
 - 1) The controller shall be BTL listed/certified.
 - 2) The controller shall be tested and certified as a BACnet Advanced Application Controller (B-AAC).
 - 3) A BACnet Protocol Implementation Conformance Statement shall be provided for the controller.
 - 4) The Conformance Statement shall be submitted 10 days prior to bidding.
3. The controller shall support 14 pre-built single duct VAV box control applications to allow the Controller to be made fully operational without the need to create a custom program.
4. The controller shall employ finite state programming to eliminate unnecessary conflicts between control functions at crossover points in their operational sequences. Suppliers using non-state based DDC shall provide separate control strategy diagrams for all controlled functions in their submittals.
5. The controllers shall be factory programmed with a continuous adaptive tuning algorithm that senses changes in the physical environment and continually adjusts loop tuning parameters appropriately. Controllers that require manual tuning of loops or perform automatic tuning on command only shall not be acceptable.
6. The controller shall be assembled in a plenum-rated plastic housing with protection class IP20 (IEC529) and flammability rated to UL94-5VB.
7. The controller shall include an integral real-time clock and support time-based tasks which enables these equipment Controllers to monitor and control:
 - a. Schedules
 - b. Calendars
 - c. Alarms
 - d. Trends
8. The controller can continue time-based monitoring when offline for extended periods of time from a network.
9. The controller shall include an integral differential pressure transducer and damper actuator. An additional configuration option shall be available that also includes an integral potentiometer for actual damper position feedback. All components shall be connected and mounted as a single assembly, removable as one piece.
10. The integral damper actuator shall be a fast response stepper motor capable of stroking 90 degrees in 60 seconds for quick damper positioning to speed commissioning and troubleshooting tasks.
11. The controller shall determine airflow by a state-of-the-art, digital, non-flow pressure sensor that supports automatic correction for polarity on high- and low-

pressure DP tube connections to eliminate high- and low-pressure connection mistakes.

12. The controller shall have the ability to automatically calibrate the flow sensor to eliminate pressure transducer offset error due to ambient temperature / humidity effects.
13. The controller can operate as a stand-alone Controller in applications that do not require a networked supervisory device or for network applications where it is preferred to have the scheduling, alarming, and/or trending performed locally in the equipment Controllers.
14. The CVM shall include troubleshooting LEDs to indicate the following conditions:
 - a. Power—to indicate if the Controller is powered or not powered
 - b. Fault – to indicate if the Controller is in its default state, has no faults, has a device fault, is in startup or download mode, or has an SA Bus communication issue
 - c. SA Bus – to indicate if SA Bus communication is occurring and normal, is not occurring, or was occurring but has been lost and is waiting to rejoin
 - d. FC Bus – to indicate if FC Bus communication is occurring and normal, is not occurring, or was occurring but has been lost and is waiting to rejoin
 - e. EOL – to indicate if the end-of-line termination switch is on or off
15. The controller shall include troubleshooting LEDs to indicate the following conditions:
 - a. Power—to indicate if the Controller is powered or not powered
 - b. Fault - to indicate if the Controller is in its default state, has no faults, has a device fault, is in startup or download mode, or has an SA Bus communication issue
 - c. SA Bus– to indicate if SA Bus communication is occurring and normal, is not occurring, or was occurring but has been lost and is waiting to rejoin
 - d. ETH-1 - to indicate if the Controller is connected and communicating, or is not connected
 - e. ETH-2 - to indicate if the Controller is connected and communicating, or is not connected
16. The controller shall have the ability to transfer and apply firmware files to all SA Bus devices connected to it.
17. The controller shall include pluggable screw terminal blocks for all I/O, FC and SA Bus communication, and power wiring connections.

18. The controller shall accommodate the direct wiring of analog and binary I/O field points with the following resolution.
 - a. Inputs – 24-bit analog-to-digital converter
 - b. Outputs – +/- 200 mV accuracy in 0-10 VDC applications
19. The controller shall support the following types of inputs and outputs supplied in the amounts required for the specified applications:
 - a. Universal Inputs – shall be configurable to monitor any of the following:
 - 1) 0-10 VDC analog input
 - 2) 4-20 mA analog input
 - 3) 0-600k ohms analog input
 - 4) Dry contact binary input
 - b. Binary Outputs – shall output the following:
 - 1) 24 VAC Triac binary outputs
 - c. Configurable Outputs – shall be configurable of outputting the following:
 - 1) 0-10 VDC analog output
 - 2) 24 VAC Triac binary output
20. The controller shall have the ability to reside on a Field Controller Bus (FC Bus).
 - a. The FC Bus shall be a MS/TP Bus supporting BACnet Standard protocol SSPC-135.
 - b. The FC Bus shall support communications between the CVMs and the supervisory Controller.
 - c. The FC Bus shall also support peer-to-peer communications between non-supervisory devices, allowing these devices to communicate system data with each other directly, bypassing the supervisory network engine on the bus.
 - d. The FC Bus shall support a minimum of 100 equipment Controllers and/or expansion modules in any combination.
 - e. The FC Bus shall operate at a maximum distance of 15,000 Ft. between the CVM and the furthest connected device.
21. The controller shall have the ability to reside on the Automation Network with the following capabilities
 - a. The CVE shall communicate with Open Data Servers (BACnet listed OWS) and Network Engines.
 - b. The CVE shall support BACnet IPv4
 - c. The CVE shall support Peer to Peer communications with other Controllers on the automation network

22. The controller shall include three (3) decimal rotary dial switches for setting the BACnet MS/TP device address.
23. The controller shall include three (3) decimal rotary dial switches for setting the Controller number.
24. The controller shall have the ability to monitor and control a network of sensors and actuators over a SA Bus.
 - a. The SA Bus shall be a MS/TP Bus supporting BACnet Standard Protocol SSPC-135.
 - b. The SA Bus shall support a minimum of 10 devices per trunk.
 - c. The SA Bus shall operate at a maximum distance of 1,200 Ft. between the CVM/CVE and the furthest connected device.
25. The controller shall have the capability to execute VAV box control sequences involving direct wired I/O points as well as input and output devices communicating over a MS/TP Bus.
26. The Controller shall utilize a proportional plus integration (PI) algorithm for the space temperature control loops.
27. Each Controller shall continuously, adaptively tune the control algorithms to improve control and Controller reliability through reduced actuator duty cycle. In addition, this tuning reduces commissioning costs, and eliminates the maintenance costs of manually re-tuning loops to compensate for seasonal or other load changes.
28. The Controller shall provide the ability to download and upload VAV box control application configuration files, both locally and via the communications network. Controllers shall be able to be loaded individually or as a group.
29. Control setpoint changes initiated over the network shall be written to the Controller's non-volatile memory to prevent loss of setpoint changes and to provide consistent operation in the event of communication failure.
30. The Controller firmware shall be flash-upgradeable remotely via the communications bus to minimize costs of feature enhancements.
31. The Controller shall provide fail-soft operation if the airflow signal becomes unreliable, by automatically reverting to a pressure-dependent control mode.
32. The Controller shall interface with balancer tools that allow automatic recalculation of box flow pickup gain ("K" factor), and the ability to directly command the airflow control loop to the box minimum and maximum airflow setpoints.
33. The Controller shall have on-board diagnostics. These diagnostics shall consist of control loop performance measurements executing at each control loop's sample interval, which may be used to continuously monitor and document system performance. The CVM/CVE shall calculate Exponentially Weighted Moving Averages (EWMA) for each of the following metrics, which shall be available to the end user for efficient management of the VAV terminals.

- a. Absolute temperature loop error
 - b. Signed temperature loop error
 - c. Absolute airflow loop error
 - d. Signed airflow loop error
 - e. Average damper actuator duty cycle
34. The Controller shall detect system error conditions to assist in managing the VAV zones. The error conditions shall consist of:
- a. Unreliable space temperature sensor
 - b. Unreliable differential pressure sensor
 - c. Starved box
 - d. Actuator stall
 - e. Insufficient cooling
 - f. Insufficient heating
35. The Controller shall provide a flow test function to view damper position vs. flow in a graphical format. The information would alert the user to check damper position. The CVM/CVE would also provide a method to calculate actuator duty cycle as an indicator of damper actuator runtime.
36. The Controller shall provide a compliant interface for ASHRAE Standard 62-1989 (indoor air quality) and shall be capable of resetting the box minimum airflow based on the percent of outdoor air in the primary air stream.
37. The Controller shall comply with ASHRAE Standard 90.1 (energy efficiency) by preventing simultaneous heating and cooling, and where the control strategy requires reset of airflow while in reheat, by modulating the box reheat device fully open prior to increasing the airflow in the heating sequence.
38. Provide “Insert manufacturers” or approved equivalent as shown on plans.
39. Equipment Controllers shall be programmed using the ASHRAE Guideline 36: High-Performance Sequences of Operation for HVAC Systems

C. XPM expansion I/O module (XPM)

- 1. The XPM provides additional input and output interfaces for use in digital Controllers.
- 2. The XPM shall communicate with Controllers over the FC Bus or the SA Bus.
- 3. The XPM shall support BACnet Standard ANSI/ASHRAE 135.
 - a. The XPM shall be BTL listed/certified and carry the BTL Label.

- b. The XPM shall be tested and certified as a BACnet Smart Actuator (B-SA).
 - c. A BACnet Protocol Implementation Conformance Statement shall be provided for the XPM.
 - d. The Conformance Statement shall be submitted 10 days prior to bidding.
4. The XPM shall include pluggable screw terminal blocks for all I/O, SA/FC bus communication, and power wiring connections.
 5. The XPM shall include three (3) decimal rotary dial switches for setting the BACnet MS/TP device address.
 6. The XPM shall accommodate the direct wiring of analog and binary I/O field points with the following resolution:
 - a. Inputs – 24-bit analog-to-digital converter
 - b. Outputs – +/- 200 mV accuracy in 0-10 VDC applications
 7. The XPM shall support the following types of inputs and outputs:
 - a. Universal Inputs – shall be configured to monitor any of the following:
 - 1) 0-10 VDC analog input
 - 2) 4-20 mA analog input
 - 3) 0-600k ohms analog input
 - 4) Dry contact binary input
 - b. Binary Inputs – shall be configured to monitor either of the following:
 - 1) Dry Contact Maintained Mode
 - 2) Pulse Counter Mode
 - c. Analog Outputs – shall be configured to output either of the following:
 - 1) 0-10 VDC analog output
 - 2) 4-20 mA analog output
 - d. Binary Outputs – shall output the following:
 - 1) 24 VAC Triac
 - e. Configurable Outputs – shall be capable of the following:
 - 1) 0-10 VDC analog output
 - 2) 24 VAC Triac binary output
 8. The XPM shall include troubleshooting LEDs to indicate the following conditions:
 - a. Power – to indicate if the device is powered or not powered

- b. Fault – to indicate if the device is in its default state, has no faults, has a device fault, is in startup or download mode, or has an SA Bus communication issue
- c. SA/FC Bus – to indicate if bus communication is occurring and normal, is not occurring, or was occurring but has been lost and is waiting to rejoin
- d. EOL – to indicate if the end of line termination is on or off.

9. Provide Johnson Controls XPM or approved equivalent as shown on plans.

2.05 PROGRAMMABLE EQUIPMENT CONTROLLERS

- A. Programmable equipment Controllers shall include direct wired input interfaces for monitoring analog and binary signals from field devices.
- B. Programmable equipment Controllers shall include direct wired output interfaces for controlling field equipment.
- C. Programmable equipment Controllers shall include a BACnet MS/TP or optionally N2Open field bus network interface.
 - 1. Programmable equipment Controllers shall be BACnet Testing Labs (BTL) listed.
 - 2. Programmable equipment Controllers shall be tested and certified as a BACnet Application Specific Controller (B-ASC) or as BACnet Advanced Application Controller (B-AAC).
 - 3. A BACnet Protocol Implementation Conformance Statement shall be provided for the programmable equipment Controllers 10 days prior to bidding.
- D. Programmable equipment Controllers shall include an expansion sensor and actuator bus (SA Bus) network interface, for interfacing up to 9 of the following types of devices:
 - 1. Expansion input/output modules (FX-PCX, F4-XPM)
 - 2. Network sensors (NS-xxx), of the following types and characteristics:
 - a. Network room temperature and humidity sensor(s)
 - 1) The network room temperature and humidity sensors shall be suitable for mounting in an occupied space.
 - 2) The network room temperature and humidity sensor(s) shall be available in either surface mount or wall mount packaging.
 - 3) The network room temperature and humidity sensor(s) shall include either screw terminals or 6-pin RJ-style modular jack for SA Bus wiring connections.
 - 4) The network room temperature and humidity sensor(s) shall have the ability to monitor the following variables as required by the system's sequence of operations:
 - a) Zone temperature
 - b) Zone humidity

- c) Zone setpoint
 - 5) The network room temperature and humidity sensor(s) shall include the following operator controls:
 - a) A backlit Liquid Crystal Display (LCD) to indicate the temperature, humidity and setpoint
 - b) An LED to indicate the status of the Override feature
 - c) A button to toggle the temperature display between Fahrenheit and Celsius
 - d) A button to program the display for temperature or humidity
 - e) A button to initiate a timed override command
 - f) A dial to change the setpoint or warmer/cooler adjustment.
 - b. Network room CO2 sensor(s):
 - 1) The network room CO2 sensor(s) shall be suitable for mounting in an occupied space
 - 2) The network room CO2 sensor(s) shall be available in either surface mount or wall mount packaging.
 - 3) The network room CO2 sensor(s) shall include either screw terminals or 6-pin RJ-style modular jack for SA Bus wiring connections.
 - 4) The network room CO2 sensor(s) measurement range shall be 0-2,000 ppm.
 - c. Network discharge air temperature sensor(s):
 - 1) The network discharge air temperature sensor(s) shall be suitable for mounting in supply or discharge air duct.
 - 2) The network discharge air temperature sensor(s) shall include a 4 inch or 8 inch duct insertion probe.
 - 3) The network discharge air temperature sensor(s) shall include 10 foot pigtail type wiring lead.
- 3. Variable speed drive(s)
- 4. Local display/keypad (FX-DIS17) with the following characteristics:
 - a. The local display/keypad shall allow the user to view monitored points without logging into the system.
 - b. The local display/keypad shall allow the user to view and change setpoints, modes of operation, and parameters.
 - c. The local display/keypad shall provide password protection with user adjustable password timeout.
 - d. The local display/keypad shall be menu driven with separate paths for:
 - 1) Input/Output
 - 2) Parameter/Setpoint
 - 3) Overrides

- e. The local display/keypad shall use easy-to-read English text messages.
 - f. The local display/keypad shall allow the user to select the points to be shown and in what order.
 - g. The local display/keypad shall support a back lit Liquid Crystal Display (LCD) with adjustable contrast and brightness and automatic backlight brightening during user interaction.
 - h. The local display/keypad shall be a minimum of 4 lines and a minimum of 20 characters per line
 - i. The local display/keypad shall have a keypad with no more than 6 keys.
 - j. The local display/keypad shall be panel mountable.
5. Air balancing tool
6. One-to-one wireless room sensor receiver (FX-WRZ7860), with the following capabilities:
- a. The one-to-one wireless room sensor receiver shall receive wireless radio frequency (RF) signals containing temperature, humidity and occupancy data from multiple wireless room sensors (WRZ sensors) and communicate this information to programmable equipment Controllers via the Sensor Actuator (SA) Bus.
 - b. The one-to-one wireless room sensor receiver shall use direct sequence spread spectrum RF technology.
 - c. The one-to-one wireless room sensor receiver shall operate on the 2.4 GHZ ISM Band.
 - d. The one-to-one wireless room sensor receiver shall meet the IEEE 802.15.4 standard for low-power, low duty-cycle RF transmitting systems.
 - e. The one-to-one wireless room sensor receiver shall be FCC compliant to CFR Part 15 subpart B Class A.
 - f. The one-to-one wireless room sensor receiver shall operate as a bidirectional transceiver with the sensors to confirm and synchronize data transmission.
 - g. The one-to-one wireless room sensor receiver shall be capable of communication with from one to five wireless room sensors up to a distance of 200 Feet.
 - h. The one-to-one wireless room sensor receiver shall be assembled in a plenum rated plastic housing with flammability rated to UL94-5VB.
 - i. The one-to-one wireless room sensor receiver shall have LED indicators to provide information regarding the following conditions:
 - 1) Power

- 2) SA Bus - Receiver Activity/No Activity
 - 3) Wireless RF - Transmission from sensors/No Transmission
 - 4) Wireless Rapid Transmit Mode - No transmission/ weak signal/Adequate signal/Excellent signal
- j. The one-to-one wireless room sensor receiver shall receive room temperature, humidity, and occupied information from the wireless room sensors, which shall include the following capabilities:
- 1) The wireless room sensors shall use direct sequence spread spectrum RF technology.
 - 2) The wireless room sensors shall operate on the 2.4 GHZ ISM Band.
 - 3) The wireless room sensors shall meet the IEEE 802.15.4 standard for low-power, low duty-cycle RF transmitting systems.
 - 4) The wireless room sensors shall be FCC compliant to CFR Part 15 subpart B Class A.
 - 5) The wireless room sensors shall be available with:
 - a) Warmer/Cooler Set Point Adjustment
 - b) No Set Point Adjustment
 - c) Set Point Adjustment Scale - 55 to 85° F.
 - 6) The wireless room sensors shall be assembled in NEMA 1 plastic housings.
- E. Programmable equipment Controllers shall have the capability to execute complex control sequences involving direct wired input/output points as well as input and output devices communicating over the FC Bus or the SA Bus.
- F. Programmable equipment Controllers shall employ a finite state control engine to eliminate unnecessary conflicts between control functions at crossover points in their operational sequences. Suppliers using non-state based DDC shall provide separate control strategy diagrams for all controlled functions in their submittals.
- G. Programmable equipment Controllers shall employ a continuous adaptive tuning algorithm that senses changes in the physical environment and continually adjusts loop tuning parameters appropriately. Controllers that require manual tuning of loops or perform automatic tuning on command only shall not be acceptable.
- H. Programmable control logic shall utilize a proportional plus integration (PI) algorithm for the space temperature control loops.
- I. Programmable equipment Controllers shall be fully programmable and definable using a software tool with the following characteristics:
1. A simple, check-the-box or selection-type wizard method, with selections for the most popular HVAC equipment and control strategy options.
 2. A graphical, functional logic block editor for creating new or editing existing programming logic.
- J. Programmable equipment Controllers shall provide the ability to be downloaded and uploaded either locally or using the communications network. Programmable equipment Controllers shall support being loaded individually or as a group

- K. Control setpoint changes initiated over the network shall be written to programmable equipment Controllers' non-volatile memory to prevent loss of setpoint changes and to provide consistent operation in the event of communication failure.
- L. Programmable equipment Controllers' firmware shall be flash-upgradeable remotely via the communications bus to minimize costs of feature enhancements.
- M. Programmable equipment Controllers shall be assembled in a plenum-rated plastic housing with flammability rated to UL94-5VB or the Controller is designed and suitable for use in other environmental air space (plenums) in accordance with Section 300.252(C) of the National Electrical Code.
- N. The programmable equipment Controllers shall include troubleshooting LED indicators to identify the following conditions:
 - 1. Power On
 - 2. Power Off
 - 3. Download or Startup in progress, not ready for normal operation
 - 4. No Faults
 - 5. Device Fault
 - 6. Field Controller Bus - Normal Data Transmission
 - 7. Field Controller Bus - No Data Transmission
 - 8. Field Controller Bus - No Communication
 - 9. Sensor-Actuator Bus - Normal Data Transmission
 - 10. Sensor-Actuator Bus - No Data Transmission
 - 11. Sensor-Actuator Bus - No Communication
- O. Models of programmable equipment Controllers dedicated to controlling variable air volume (VAV) boxes shall be provided with the following characteristics:
 - 1. The programmable VAV box Controller shall provide both standalone and networked direct digital control of pressure-independent or pressure-dependent variable air volume terminal units, for either single or dual duct applications.
 - 2. The programmable VAV box Controller shall communicate over the Field Controller Bus using BACnet Standard protocol SSPC-135.
 - 3. The programmable VAV box Controller shall include an integrated differential pressure transducer and VAV box damper actuator, all connected and housed as a single assembly that can be mounted and removed as one piece. Alternate configurations shall be available as follows:
 - a. A configurable digital Controller with integral differential pressure transducer but without a damper actuator – for controlling large VAV boxes that require high torque.

- b. A configurable digital Controller with an integral damper actuator but without a differential pressure transducer – for commercial zoning applications or for pressure dependent VAV box applications.
 - c. A configurable digital Controller with an integral damper actuator and ball valve linkage but without a differential pressure transducer –for chilled beam applications.
- 4. The programmable VAV box Controller shall be assembled in a plenum-rated plastic housing with flammability rated to UL94-5VB or the Controller is designed and suitable for use in other environmental air space (plenums) in accordance with Section 300.252(C) of the National Electrical Code.
- 5. The integral VAV box damper actuator shall be a 4 Nm, non-spring return, fast-response actuator capable of stroking 90 degrees in 60 seconds for quick damper positioning to expedite commissioning and troubleshooting tasks.
- 6. The programmable VAV box Controller shall measure airflow using an integrated, digital, non-flow pressure sensor providing 14-bit resolution with bidirectional flow operation that supports automatic correction for polarity on high- and low-pressure DP tube connections to eliminate high- and low-pressure connection mistakes.
- 7. The programmable VAV box Controller shall have the ability to automatically calibrate the flow sensor to eliminate pressure transducer offset error due to ambient temperature / humidity effects.
- 8. The programmable VAV box Controller shall include input interface(s) to monitor the following analog signals, without the addition of equipment outside the terminal Controller cabinet:
 - a. 0-10 VDC sensors
 - b. 0-2k ohm resistive temperature detector (RTDs)
 - c. 10k Type L and 2.252k type 2 NTC thermistors
- 9. The programmable VAV box Controller shall include input interface(s) to monitor dry contact closures, with filtering to eliminate false signals resulting from input "bouncing".
- 10. The programmable VAV box Controller input interfaces shall be internally isolated from power, communications, and output circuits, for noise immunity.
- 11. The programmable VAV box Controller shall include output interface(s) with the following characteristics:
 - a. 0-10 VDC analog output
 - b. SPST triac output rated for 500mA at 24 VAC.
- 12. The programmable VAV box Controller shall continuously, adaptively tune the control algorithms to improve control and Controller reliability through reduced actuator duty cycle, to reduce commissioning costs, and to eliminate the

maintenance costs of manually re-tuning loops to compensate for seasonal or other load changes.

13. The programmable VAV box Controller shall provide fail-soft operation if the airflow signal becomes unreliable, by automatically reverting to a pressure-dependent control mode.
14. The programmable VAV box Controller shall interface with air balancer tools that allow automatic recalculation of box flow pickup gain ("K" factor), and the ability to directly command the airflow control loop to the box minimum and maximum airflow setpoints.
15. The programmable VAV box Controller shall have on-board diagnostics, including control loop performance measurements executing at each control loop's sample interval, which may be used to continuously monitor and document system performance. The programmable VAV box Controller shall calculate exponentially weighted moving averages (EWMA) for each of the following, and these metrics shall be available to the end user for efficient management of the VAV terminals.
 - a. Absolute temperature loop error
 - b. Signed temperature loop error
 - c. Absolute airflow loop error
 - d. Signed airflow loop error
 - e. Average damper actuator duty cycle
16. The programmable VAV box Controller shall detect system error conditions to assist in managing the VAV zones. The error conditions shall include:
 - a. Unreliable space temperature sensor
 - b. Unreliable differential pressure sensor
 - c. Starved box
 - d. Actuator stall
 - e. Insufficient cooling
 - f. Insufficient heating
17. The programmable VAV box Controller shall provide a flow test function to view damper position vs. flow in a graphical format. The information would alert the user to check damper position. The programmable VAV box Controller would also provide a method to calculate actuator duty cycle as an indicator of damper actuator runtime.
18. The programmable VAV box Controller shall provide a compliant interface for ASHRAE Standard 62-1989 (indoor air quality) and shall be capable of resetting the box minimum airflow based on the percent of outdoor air in the primary air stream.

19. The programmable VAV box Controller shall comply with ASHRAE Standard 90.1 (energy efficiency) by preventing simultaneous heating and cooling, and where the control strategy requires reset of airflow while in reheat, by modulating the box reheat device fully open prior to increasing the airflow in the heating sequence.
- P. Models of programmable equipment Controllers dedicated for general purpose applications (FX-PCG) shall be provided with the following characteristics:
1. The general purpose programmable equipment Controllers shall support, but not be limited to, the following applications:
 - a. Terminal units
 - b. Packaged rooftop units and heat pumps
 - c. Built-up air handling units
 - d. Chilled water/central plants
 - e. Heating central plants
 - f. Special applications as required for systems control
 2. The PCG shall be assembled in a plastic housing with flammability rated to UL94-5VB.
 3. The general purpose programmable equipment Controllers shall include input interface(s) to monitor the following analog signals, without the addition of equipment outside the Controller cabinet:
 - a. 0-10 VDC sensors
 - b. 4-20 mA sensors
 - c. 0-2k ohm resistive temperature detector (RTDs)
 - d. 10k Type L and 2.252k type 2 NTC thermistors
 4. The general purpose programmable equipment Controllers shall include input interface(s) to monitor the following binary signals:
 - a. Dry contact closures, with filtering to eliminate false signals resulting from input "bouncing".
 - b. Pulse Counter/Accumulator Mode (high speed), 100 Hz
 5. The general purpose programmable equipment Controllers' input interfaces shall be internally isolated from power, communications, and output circuits, for noise immunity.
 6. The general purpose programmable equipment Controllers shall include output interface(s) with the following characteristics:
 - a. 0-10 VDC analog output

- b. 4-20 mA analog output
 - c. SPST triac output rated for 500mA at 24 VAC.
7. The general purpose programmable equipment Controllers' output interfaces shall be internally isolated from power, communications, and other output circuits for noise immunity.
- Q. Models of programmable equipment Controllers dedicated for advanced control applications (FX-PCA) shall be provided with the following characteristics:
- 1. The advanced application equipment Controllers shall support, but not be limited to, the following applications:
 - a. Packaged rooftop units and heat pumps
 - b. Built-up air handling units
 - c. Chilled water/central plants
 - d. Heating central plants
 - e. Special applications as required for systems control
 - f. Chilled water/central plant optimization applications including but not limited to:
 - 1) Selection and sequencing of up to eight chillers of different sizes
 - 2) Selection and sequencing of up to eight (each) primary and secondary chilled water pumps of varying pumping capacities
 - 3) Selection and sequencing of up to eight condenser water pumps
 - 4) Selection and sequencing of cooling towers and bypass valve, including single speed, multi-speed, and Vernier control
 - 5) Selection and sequencing of up to four heat exchangers, of different capacities
 - 6) A proven and documented central cooling plant optimization program that incorporates custom equipment efficiency profiles, without rewriting software code, in order to meet the building load using the least amount of energy as calculated.
 - 7) The use of advanced control algorithms that apply equipment specific parameters, including operational limits and efficiency profiles, in order to determine equipment start and runtime preferences
 - 8) Identification of the most efficient equipment combination and automatic control of state and speed of all necessary equipment to balance runtime, optimize timing and sequencing and ensure the efficiency and stability of the central cooling plant
 - g. Equipment not using a networked supervisory Controller or where it is preferred to have the scheduling, alarming, and/or trending performed locally in the equipment Controllers.
 - 2. The PCA Controllers shall communicate via BACnet MS/TP or BACnet/IP communication protocols, depending on the model.

3. The PCA shall be assembled in a plastic housing with flammability rated to UL94-5VB.
4. The advanced application equipment Controllers shall include an integral real-time clock which enables them to locally provide the following time-based application services:
 - a. Scheduling
 - b. Alarming
 - c. Trending
5. The advanced application equipment Controllers shall continue time-based monitoring when offline from a supervisory Controller for extended periods of time.
6. The advanced application equipment Controllers shall include input interface(s) to monitor the following analog signals, without the addition of equipment outside the Controller cabinet:
 - a. 0-10 VDC sensors
 - b. 4-20 mA sensors
 - c. 0-2k ohm resistive temperature detector (RTDs)
 - d. 10k Type L and 2.252k type 2 NTC thermistors
7. The advanced application equipment Controllers shall include input interface(s) to monitor the following binary signals:
 - a. Dry contact closures, with filtering to eliminate false signals resulting from input "bouncing".
 - b. Pulse Counter/Accumulator Mode (high speed), 100 Hz
8. The advanced application equipment Controllers shall be internally isolated from power, communications, and output circuits, for noise immunity.
9. The advanced application equipment Controllers shall include output interface(s) with the following characteristics:
 - a. 0-10 VDC analog output
 - b. 4-20 mA analog output
 - c. SPST triac output rated for 500mA at 24 VAC.
 - d. SPST relay outputs
 - e. SPDT relay outputs

10. The advanced application equipment Controllers' output interfaces shall be internally isolated from power, communications, and other output circuits for noise immunity.
11. The advanced application equipment Controllers shall support an optional, display/keypad integrated into the Controller's housing face, with the following characteristics:
 - a. The integrated display/keypad shall allow the user to view monitored points without logging into the system.
 - b. The integrated display/keypad shall allow the user to view and change setpoints, modes of operation, and parameters.
 - c. The integrated display/keypad shall provide password protection with user adjustable password timeout.
 - d. The integrated display/keypad shall be menu driven with separate paths for:
 - 1) Input/Output
 - 2) Parameter/Setpoint
 - 3) Overrides
 - e. The integrated display/keypad shall use easy-to-read English text messages.
 - f. The integrated display/keypad shall allow the user to select the points to be shown and in what order.
 - g. The integrated display/keypad shall support a back lit Liquid Crystal Display (LCD) with adjustable contrast and brightness and automatic backlight brightening during user interaction.
 - h. The integrated display/keypad shall be a minimum of 4 lines and a minimum of 20 characters per line.
 - i. The integrated display/keypad shall have a keypad with no more than 6 keys.

R. Models of programmable equipment Controllers dedicated for chilled beam applications (FX-PCV1656) shall be provided with the following characteristics:

1. The programmable chilled beam Controllers shall include an integrated 4 Nm, non-spring return actuator and ball valve linkage for use with the Johnson Controls VG-1000 1/2 - 1 inch valves.
2. The programmable chilled beam Controllers shall include input interface(s) to monitor the following analog signals, without the addition of equipment outside the terminal Controller cabinet:
 - a. 0-10 VDC sensors
 - b. 0-2k ohm resistive temperature detector (RTDs)

- c. 10k Type L and 2.252k type 2 NTC thermistors
- 3. The programmable chilled beam Controllers shall include input interface(s) to monitor dry contact closures, with filtering to eliminate false signals resulting from input "bouncing".
- 4. The programmable chilled beam Controllers input interfaces shall be internally isolated from power, communications, and output circuits, for noise immunity.
- 5. The programmable chilled beam Controllers shall include output interface(s) with the following characteristics:
 - a. 0-10 VDC analog output
 - b. SPST triac output rated for 500mA at 24 VAC.
- 6. The programmable chilled beam Controllers' output interfaces shall be internally isolated from power, communications, and other output circuits for noise immunity.
- 7. The programmable chilled beam Controller shall include an integral actuator and ball valve linkage for use with the Johnson Controls VG-1000 1/2 - 1 inch valves.

2.06 FIELD BUS NETWORK

- A. The field bus network shall support communications and data exchange between the equipment Controller(s) and the supervisory Controller(s).
- B. The field bus network shall be a MS/TP Bus supporting BACnet Standard protocol SSPC-135, Clause 9.
- C. The field bus network cabling shall be 22 AWG, stranded, 3-wire twisted, shielded cable.
- D. End of line (EOL) termination shall be used on the two devices located at either end of each field bus network segment.
- E. The field bus network shall support a maximum 3 bus segments.
- F. A field bus network segment shall support a maximum of 32 devices.
- G. Each field bus network segment shall be up to 1,220 m (4,000 ft) in length.
- H. Each field bus network shall be up to 3,660 m (12,000 ft) in length.
- I. End of line (EOL) termination shall be used on the two devices located at either end of each field bus network segment.

2.07 NETWORK THERMOSTATS

- A. Network Thermostat – Fan Coil and Zoning
 - 1. The network thermostat shall be capable of controlling two- or four-pipe fan coils, cabinet unit heaters, a pressure dependent VAV System, zoning type

systems employing reheat including local hydronic reheat valves, or other similar equipment.

2. The Networked Thermostat shall communicate over the FC Bus using BACnet Standard protocol SSPC-135.
3. Communications shall be selectable locally at thermostat through the display.
4. The TEC shall be BTL listed/certified and carry the BTL Label.
 - a. The TEC shall be tested and certified as a BACnet Application Specific Controller (B-ASC).
 - b. A BACnet Protocol Implementation Conformance Statement shall be provided for the TEC.
 - c. The Conformance Statement shall be submitted 10 days prior to bidding.
5. The network thermostat shall include a LED backlit touch screen with the following configurable icons.
 - a. Home screen configurable icons include:
 - 1) On/Off icon
 - 2) Fan override icon
 - 3) Zone temperature icon
 - 4) Hold temperature icon
 - 5) Zone humidity (on applicable models) icon
 - 6) Occupancy status (on applicable models) icon
 - 7) Temperature setpoint icon
 - 8) Alarm icon
 - 9) Unit status icon
 - 10) Date/Time icon
 - 11) Fan override icon
 - b. Home screen non-configurable icon includes:
 - 1) Menu icon
6. The network thermostat shall provide the flexibility to support any one of the following inputs:
 - a. Integral indoor air temperature sensor.
 - b. Analog input for remote air temperature sensing that supports the following sensor types.
 - 1) Nickel
 - 2) Platinum
 - 3) A99B PENN
 - 4) 2.25k ohm NTC
 - 5) 10k ohm NTC
 - 6) 10k ohm NTC Type 3
 - c. Universal input that supports the following configurations:

- 1) Analog sensor
 - 2) Cooling when switch is closed
 - 3) Heating when switch is closed
- d. Remote indoor air temperature sensor.
- e. Two configurable binary inputs with the following configurations:
- 1) Disabled
 - 2) Occupancy
 - 3) Override
 - 4) Remote PIR
 - 5) Dirty filter
 - 6) Service
 - 7) Fan Lock
 - 8) Open door
 - 9) Open window
7. The network thermostat shall provide 4 digit passcode security.
8. The network thermostat shall employ nonvolatile EEPROM for all adjustable parameters.
9. The network thermostat shall have a temperature accuracy of $\pm 0.9^{\circ}\text{F}/\pm 0.5^{\circ}\text{C}$ at $70.0^{\circ}\text{F}/21.0^{\circ}\text{C}$ typical calibrated.
10. The network thermostat shall have a humidity accuracy of $\pm 5\%$ RH from 20 to 80% RH at 50 to 90°F (10 to 32°C.)
11. The network thermostat shall provide user equipment visibility from a mobile device through the MAP.
12. On/off or floating fan coil and zoning applications:
- a. The network thermostat shall be capable of controlling two- or four-pipe fan coils, cabinet unit heaters, a pressure dependent VAV System, zoning type systems employing reheat including local hydronic reheat valves, or other similar equipment.
13. The network thermostat shall provide the flexibility to support any one of the following fan outputs:
- a. Three speed fan control
 - b. Proportional speed fan control configurable from 0 to 10V
14. The network thermostat shall provide the flexibility to support any one of the following valve outputs:
- a. Two on/off
 - b. Two floating
15. The network thermostat shall provide the flexibility to adjust the following control parameters:

- a. Adjustable maximum setpoint offset from 0 to 20°F
 - b. Adjustable fan on delay from 0 to 120 seconds
 - c. Adjustable fan off delay from 0 to 120 seconds
 - d. Adjustable minimum cooling on time from 0 to 360 seconds
 - e. Adjustable minimum cooling off time from 0 to 360 seconds
 - f. Adjustable minimum heating on time from 0 to 360 seconds
 - g. Adjustable minimum heating off time from 0 to 360 seconds
 - h. Adjustable minimum reheat on time from 0 to 360 seconds
 - i. Adjustable minimum reheat off time from 0 to 360 seconds
 - j. Adjustable stroke time from 5 to 300 seconds
 - k. Adjustable supply fan minimum command from 0 to 100%
 - l. Adjustable supply fan Medium command from 0 to 100%
 - m. Adjustable supply fan high command from 0 to 100%
 - n. Adjustable reheat minimum damper position from 0 to 100%
16. Provide Johnson Controls TEC361x or approved equivalent as indicated on plans.

B. Network Thermostat– RTU/heat pump with economizer

- 1. The network thermostat shall be capable of controlling the following types of split or packaged units:
 - a. Cooling only units
 - b. Cooling units with gas or electric heat
 - c. Heat pumps
 - d. Units with economizers
- 2. The Networked Thermostat shall communicate over the FC Bus using BACnet Standard protocol SSPC-135 or Johnson Controls N2 protocol.
 - a. Communications shall be selectable locally at thermostat through the display.
- 3. The TEC shall be BTL listed/certified and carry the BTL Label.
 - a. The TEC shall be tested and certified as a BACnet Application Specific Controller (B-ASC).

- b. A BACnet Protocol Implementation Conformance Statement shall be submitted for the TEC.
 - c. The Conformance Statement shall be submitted 10 days prior to bidding.
4. The network thermostat shall include a 4.2 inch LED backlit touch screen with the following configurable icons.
- a. Home screen configurable icons include:
 - 1) On/Off icon
 - 2) Fan override icon
 - 3) Zone temperature icon
 - 4) Hold temperature icon
 - 5) Zone humidity (on applicable models) icon
 - 6) Occupancy status (on applicable models) icon
 - 7) Temperature setpoint icon
 - 8) Alarm icon
 - 9) Unit status icon
 - 10) Date/Time icon
 - 11) Fan override icon
 - 12) Home screen non-configurable icon includes:
 - 13) Menu icon
5. The network thermostat shall provide the flexibility to support any one of the following inputs:
- a. Integral indoor air temperature sensor.
 - b. Analog input for remote air temperature sensing that supports the following sensor types:
 - 1) Nickel
 - 2) Platinum
 - 3) A99B PENN
 - 4) 2.25k ohm NTC
 - 5) 10k ohm NTC
 - 6) 10k ohm NTC Type 3
 - c. Remote indoor air temperature sensor.
 - d. Analog input for outdoor air temperature sensor.
 - e. Analog input for remote temperature monitoring.
 - f. Two configurable binary inputs with the following configurations:
 - 1) Disabled
 - 2) Occupancy
 - 3) Override
 - 4) Remote PIR
 - 5) Dirty filter
 - 6) Service
 - 7) Fan Lock
 - 8) Open door

- 9) Open window
6. The network thermostat shall provide the flexibility to support any one of the following outputs:
 - a. Up to two heating stages
 - b. Up to two cooling stages
 7. The network thermostat shall provide 4 digit passcode security.
 8. The network thermostat shall provide the flexibility to adjust the following control parameters:
 - a. Adjustable compressor minimum on time from 0 to 360 seconds
 - b. Adjustable compressor minimum off time from 0 to 360 seconds
 - c. Adjustable maximum setpoint offset from 0 to 20°F
 - d. Adjustable heating minimum on time from 0 to 360 seconds
 - e. Adjustable heating minimum off time from 0 to 360 seconds
 - f. Adjustable cooling lockout temperature from 0 to 100°F
 - g. Adjustable heating lockout temperature from 0 to 100°F
 - h. Adjustable supplemental minimum on time from 0 to 360 seconds
 - i. Adjustable supplemental minimum off time from 0 to 360 seconds
 - j. Adjustable economizer minimum position from 0 to 100%
 - k. Adjustable economizer dry bulb setpoint from 0 to 100°F
 - l. Adjustable compressor low lockout temperature from -20 to 100°F
 - m. Adjustable compressor high lockout temperature from -20 to 100°F
 9. The network thermostat shall employ nonvolatile electrically EEPROM for all adjustable parameters.
 10. The network thermostat shall have a temperature accuracy of $\pm 0.9^{\circ}\text{F}/\pm 0.5^{\circ}\text{C}$ at 70.0°F/21.0°C typical calibrated.
 11. Where required by application and indicated on plans or room schedules provide the network thermostat with an integral Passive Infra-Red (PIR) occupancy sensor model.
 12. The network thermostat shall provide user equipment visibility from a mobile device through the MAP.
 13. Provide Johnson Controls TEC363x or approved equivalent as indicated on plans.

C. Standalone Thermostat – Fan Coil and Zoning

1. The standalone thermostat shall be capable of controlling two- or four-pipe fan coils, cabinet unit heaters, a pressure dependent VAV system, zoning type systems employing reheat including local hydronic reheat valves, or other similar equipment.
2. The standalone thermostat shall include a 4.2 inch LED backlit touch screen with the following configurable icons.
 - a. Home screen configurable icons include:
 - 1) On/Off icon
 - 2) Fan override icon
 - 3) Zone temperature icon
 - 4) Hold temperature icon
 - 5) Zone humidity (on applicable models) icon
 - 6) Occupancy status (on applicable models) icon
 - 7) Temperature setpoint icon
 - 8) Alarm icon
 - 9) Unit status icon
 - 10) Date/Time icon
 - 11) Fan override icon
 - b. Home screen non-configurable icon includes:
 - 1) Menu icon
3. The standalone thermostat shall provide the flexibility to support any one of the following inputs:
 - a. Integral indoor air temperature sensor.
 - b. Analog input for remote air temperature sensing that supports the following sensor types:
 - 1) Nickel
 - 2) Platinum
 - 3) A99B PENN
 - 4) 2.25k ohm NTC
 - 5) 10k ohm NTC
 - 6) 10k ohm NTC Type 3
 - c. Universal input that supports the following configurations.
 - 1) Analog sensor
 - 2) Cooling when switch is closed
 - 3) Heating when switch is closed
 - d. Remote indoor air temperature sensor
 - e. Two configurable binary inputs with the following configurations.
 - 1) Disabled
 - 2) Occupancy

- 3) Override
- 4) Remote PIR
- 5) Dirty filter
- 6) Service
- 7) Fan Lock
- 8) Open door
- 9) Open window

- 4. The standalone thermostat shall provide 4 digit passcode security.
- 5. The standalone thermostat shall employ nonvolatile electrically erasable programmable read-only memory (EEPROM) for all adjustable parameters.
- 6. The standalone thermostat shall have a temperature accuracy of $\pm 0.9^{\circ}\text{F}/\pm 0.5^{\circ}\text{C}$ at $70.0^{\circ}\text{F}/21.0^{\circ}\text{C}$ typical calibrated.
- 7. The standalone thermostat shall have a humidity accuracy of $\pm 5\%$ RH from 20 to 80% RH at 50 to 90°F (10 to 32°C.)
- 8. On/Off or Floating fan coil and zoning applications.
 - a. The standalone thermostat shall provide the flexibility to support any one of the following fan outputs:
 - 1) Three speed fan control
 - 2) Proportional speed fan control configurable from 0 to 10V
 - b. The standalone thermostat shall provide the flexibility to support any one of the following valve outputs:
 - 1) Two on/off
 - 2) Two floating
 - c. The standalone thermostat shall provide the flexibility to adjust the following control parameters:
 - 1) Adjustable maximum setpoint offset from 0 to 20°F
 - 2) Adjustable fan on delay from 0 to 120 seconds
 - 3) Adjustable fan off delay from 0 to 120 seconds
 - 4) Adjustable minimum cooling on time from 0 to 360 seconds
 - 5) Adjustable minimum cooling off time from 0 to 360 seconds
 - 6) Adjustable minimum heating on time from 0 to 360 seconds
 - 7) Adjustable minimum heating off time from 0 to 360 seconds
 - 8) Adjustable minimum reheat on time from 0 to 360 seconds
 - 9) Adjustable minimum reheat off time from 0 to 360 seconds
 - 10) Adjustable stroke time from 5 to 300 seconds
 - 11) Adjustable supply fan minimum command from 0 to 100%
 - 12) Adjustable supply fan Medium command from 0 to 100%
 - 13) Adjustable supply fan high command from 0 to 100%
 - 14) Adjustable reheat minimum damper position from 0 to 100%
 - d. Provide Johnson Controls TEC331x or approved equivalent as indicated on plans.
- 9. Proportional fan coil and zoning applications

- a. The standalone thermostat shall provide the flexibility to support any one of the following fan outputs:
 - 1) Three speed fan control
 - 2) Proportional speed fan control configurable from 0 to 10V
- b. The standalone thermostat shall provide the flexibility to support the following valve outputs:
 - 1) Two proportional configurable from 0 to 10V
- c. The standalone thermostat shall provide the flexibility to adjust the following control parameters:
 - 1) Adjustable maximum setpoint offset from 0 to 20°F
 - 2) Adjustable fan on delay from 0 to 120 seconds
 - 3) Adjustable fan off delay from 0 to 120 seconds
 - 4) Adjustable minimum reheat on time from 0 to 360 seconds
 - 5) Adjustable minimum reheat off time from 0 to 360 seconds
 - 6) Adjustable supply fan minimum command from 0 to 100%
 - 7) Adjustable supply fan Medium command from 0 to 100%
 - 8) Adjustable supply fan high command from 0 to 100%
 - 9) Adjustable reheat minimum damper position from 0 to 100%
 - 10) Adjustable proportional valve opened voltage from 0 to 10 VDC
 - 11) Adjustable proportional valve closed voltage from 0 to 10 VDC
- d. Provide Johnson Controls TEC322x or approved equivalent as indicated on plans.
- e. Where required by application and indicated on plans or room schedules provide the standalone thermostat with an integral Passive Infra-Red (PIR) occupancy sensor with a field of 94 angular degrees up to a distance of 15 ft., clear line of sight.
- f. Where required by application and indicated on plans or room schedules provide the standalone thermostat with an integral relative humidity sensor.

D. Standalone Thermostat – RTU/heat pump with economizer

- 1. The standalone thermostat shall be capable of controlling the following types of split or packaged units:
 - a. Cooling only units
 - b. Cooling only units with gas or electric heat
 - c. Heat pumps
 - d. Units with economizers
- 2. The standalone thermostat shall include a 4.2 inch LED backlit touch screen with the following configurable icons.
 - a. Home screen configurable icons include:

- 1) On/Off icon
 - 2) Fan override icon
 - 3) Zone temperature icon
 - 4) Hold temperature icon
 - 5) Zone humidity (on applicable models) icon
 - 6) Occupancy status (on applicable models) icon
 - 7) Temperature setpoint icon
 - 8) Alarm icon
 - 9) Unit status icon
 - 10) Date/Time icon
 - 11) Fan override icon
- b. Home screen non-configurable icon includes:
- 1) Menu icon
3. The standalone thermostat shall provide the flexibility to support any one of the following inputs:
- a. Integral indoor air temperature sensor.
 - b. Analog input for remote air temperature sensing that supports the following sensor types:
 - 1) Nickel
 - 2) Platinum
 - 3) A99B PENN
 - 4) 2.25k ohm NTC
 - 5) 10k ohm NTC
 - 6) 10k ohm NTC Type 3
 - c. Remote indoor air temperature sensor.
 - d. Analog input for outdoor air temperature sensor.
 - e. Analog input for remote temperature monitoring.
 - f. Two configurable binary inputs with the following configurations:
 - 1) Disabled
 - 2) Occupancy
 - 3) Override
 - 4) Remote PIR
 - 5) Dirty filter
 - 6) Service
 - 7) Fan Lock
 - 8) Open door
 - 9) Open window
4. The standalone thermostat shall provide the flexibility to support the following outputs:
- a. Up to two heating stages
 - b. Up to two cooling stages

5. The standalone thermostat shall provide 4 digit passcode security.
6. The standalone thermostat shall provide the flexibility to adjust the following control parameters:
 - a. Adjustable compressor minimum on time from 0 to 360 seconds
 - b. Adjustable compressor minimum off time from 0 to 360 seconds
 - c. Adjustable maximum setpoint offset from 0 to 20°F
 - d. Adjustable heating minimum on time from 0 to 360 seconds
 - e. Adjustable heating minimum off time from 0 to 360 seconds
 - f. Adjustable cooling lockout temperature from 0 to 100°F
 - g. Adjustable heating lockout temperature from 0 to 100°F
 - h. Adjustable supplemental minimum on time from 0 to 360 seconds
 - i. Adjustable supplemental minimum off time from 0 to 360 seconds
 - j. Adjustable economizer minimum position from 0 to 100%
 - k. Adjustable economizer dry bulb setpoint from 0 to 100°F
 - l. Adjustable compressor low lockout temperature from -20 to 100°F
 - m. Adjustable compressor high lockout temperature from -20 to 100°F
7. Where required by application and indicated on plans or room schedules provide the standalone thermostat with an integral Passive Infra-Red (PIR) occupancy sensor model.
8. The standalone thermostat shall employ nonvolatile electrically erasable programmable read-only memory (EEPROM) for all adjustable parameters.
9. The standalone thermostat shall have a temperature accuracy of $\pm 0.9^{\circ}\text{F}/\pm 0.5^{\circ}\text{C}$ at $70.0^{\circ}\text{F}/21.0^{\circ}\text{C}$ typical calibrated.
10. Proportional fan coil and zoning applications.
 - a. The network thermostat shall be capable of controlling two- or four-pipe fan coils, cabinet unit heaters, a pressure dependent VAV system, zoning type systems employing reheat including local hydronic reheat valves, or other similar equipment.
 - b. The network thermostat shall provide the flexibility to support any one of the following fan outputs:
 - 1) Three speed fan control
 - 2) Proportional speed fan control configurable from 0 to 10V

- c. The network thermostat shall provide the flexibility to support the following valve outputs:
 - 1) Two proportional configurable from 0 to 10V
- d. The network thermostat shall provide the flexibility to adjust the following control parameters:
 - 1) Adjustable maximum setpoint offset from 0 to 20°F
 - 2) Adjustable fan on delay from 0 to 120 seconds
 - 3) Adjustable fan off delay from 0 to 120 seconds
 - 4) Adjustable minimum reheat on time from 0 to 360 seconds
 - 5) Adjustable minimum reheat off time from 0 to 360 seconds
 - 6) Adjustable supply fan minimum command from 0 to 100%
 - 7) Adjustable supply fan Medium command from 0 to 100%
 - 8) Adjustable supply fan high command from 0 to 100%
 - 9) Adjustable reheat minimum damper position from 0 to 100%
 - 10) Adjustable proportional valve opened voltage from 0 to 10 VDC
 - 11) Adjustable proportional valve closed voltage from 0 to 10 VDC
- 11. Provide Johnson Controls TEC362x or approved equivalent where indicated on plans.
- 12. Where required by application and indicated on plans or room schedules provide the network thermostat with an integral Passive Infra-Red (PIR) occupancy sensor.
- 13. Where required by application and indicated on plans or room schedules provide the network thermostat with an integral relative humidity sensor.

E. Network Sensors

- 1. The Network Sensors (NS) shall have the ability to monitor the following variables as required by the systems sequence of operations:
 - a. Zone Temperature
 - b. Zone Humidity
 - c. Zone Setpoint
 - d. Discharge Air Temperature
 - e. Zone CO2
- 2. The NS shall transmit the information back to the Controller on the SA Bus using BACnet Standard protocol SSPC-135.
- 3. The NS shall be BTL listed/certified and carry the BTL Label.
 - a. The NS shall be tested and certified as a BACnet Smart Sensors (B-SS).
 - b. A BACnet Protocol Implementation Conformance Statement shall be provided for the NS.

- c. The Conformance Statement shall be submitted 10 days prior to bidding.
4. The Network Zone Temperature Sensors shall include the following items:
 - a. A backlit LCD to indicate the temperature, humidity and setpoint
 - b. An LED to indicate the status of the Override feature
 - c. A button to toggle the temperature display between Fahrenheit and Celsius
 - d. A button to program the display for temperature or humidity
 - e. A button to initiate a timed override command
 - f. Available in either surface mount, wall mount, or flush mount
 - g. Available with either screw terminals or phone jack
 5. The Network Discharge Air Sensors shall include the following:
 - a. 4 inch or 8 inch duct insertion probe
 - b. Ten foot pigtail lead
 - c. Dip Switches for programmable address selection
 - d. Ability to provide an averaging temperature from multiple locations
 - e. Ability to provide a selectable temperature from multiple locations
 6. The Network CO2 Zone Sensors shall include the following:
 - a. Available in either surface mount or wall mount
 - b. Available with screw terminals or phone jack
 - c. Measurement range of 0-2000 ppm
 - d. Sensing resolution of 1 ppm
 - e. Sensing accuracy of +/- 2% of the reading plus 40 ppm
 7. Provide Johnson Controls NS series or approved equivalent where indicated on plans

F. Wireless Field Bus System

1. The Wireless Field Bus System shall employ standard IEEE802.15.4 technology to create a wireless mesh network to provide wireless connectivity for select BACnet devices at multiple system levels. This includes communications from equipment Controllers to sensors and from engines to these field Controllers. Wireless devices shall co-exist on the same network with hardwired devices. Hardwired Controllers shall be capable of retrofit to wireless devices with no special software.

2. The Wireless Field Bus Router Gateway / Coordinator shall provide a wireless interface between supported equipment Controllers and supervisory Controllers (engines) via the BACnet field bus. Each wireless mesh network shall be provided with a zone coordinator for initiation and formation of the network.
 - a. The Router Gateway / Coordinator shall function as a standard BACnet IP/MSTP Router.
 - b. The Router Gateway / Coordinator shall use direct sequence spread spectrum RF technology.
 - c. The Router Gateway / Coordinator shall operate on the 2.4 GHZ ISM Band.
 - d. The Router Gateway / Coordinator shall meet the IEEE 802.15.4 standard for low power, low duty-cycle RF transmitting systems.
 - e. The Router Gateway / Coordinator shall be FCC compliant to CFR Part 15 subpart B Class A.
 - f. The Router Gateway / Coordinator shall operate as a bidirectional transceiver with the sensors and routers to confirm and synchronize data transmission.
 - g. The Router Gateway / Coordinator shall be capable of communication with sensors and routers up to a maximum distance of 250 Feet (typical, 1000 feet line of sight).
 - h. The Router Gateway / Coordinator radio function shall be capable of being mounted at a maximum distance of 100 feet away from the Gateway
 - i. The Router Gateway / Coordinator shall be available in a variety of mounting options including panel, conduit, wall, wall box, or ceiling mount.
 - j. The Router Gateway / Coordinator shall be assembled in a plenum rated plastic housing with flammability rated to UL94-5VA.
 - k. The Router Gateway / Coordinator shall have multi-color LEDs to provide diagnostic information required for efficient operation and commissioning.
 - l. The Router Gateway / Coordinator shall support the user configuration of the wireless network PAN ID, power levels, and channels.
 - m. The Router Gateway / Coordinator shall support user configuration of the wireless network sensor reporting times for battery life optimization.
 - n. The Router Gateway / Coordinator shall support commissioning functionality to enable site optimization.
 - o. The Router Gateway / Coordinator shall support Secure Boot.

- p. The Router Gateway / Coordinator shall support 128bit AES secured communication across the wireless network
 - q. The Router Gateway / Coordinator shall provide a secure user interface via a Wi-Fi or Ethernet connection using a mobile or desktop web browser to:
 - r. Configure the wireless network settings.
 - s. View the connection status of the wireless enabled Controllers.
 - t. View and edit the Controller configurations.
3. View, edit and override Controller values. The Wireless Field Bus Router shall be used with any model MSTP Equipment Controller or VAV Modular Assembly to provide a wireless interface to network engines, via the Coordinator, and associated Wireless Mesh Room Temperature Sensors.
- a. The Router shall use direct sequence spread spectrum RF technology.
 - b. The Router shall operate on the 2.4 GHZ ISM Band.
 - c. The Router shall meet the IEEE 802.15.4 standard for low power, low duty-cycle RF transmitting systems.
 - d. The Router shall be FCC compliant to CFR Part 15 subpart B Class A.
 - e. The Router shall operate as a bidirectional transceiver with other mesh network devices to ensure network integrity.
 - f. The Router shall be capable of communication with other mesh network devices at a maximum distance of 250 feet (typical, 1000 feet line of sight).
 - g. The Router shall be capable of being mounted at a maximum distance of 100 feet away from the equipment Controller.
 - h. The Router shall be assembled in a plenum rated plastic housing with flammability rated to UL94-5VA.
 - i. The Router shall provide multi-color LED indication for use in commissioning and troubleshooting that can be disabled.
 - j. The Router shall be available in a variety of mounting options; plenum, conduit, wall, wall box, or ceiling mount.
 - k. The Router shall support the ability to be used alternatively as a wireless repeater using 24VAC without the need for an external power supply.
4. The wireless room temperature sensors shall sense and transmit room temperatures, room set point, room occupancy notification, and low battery condition to an associated Router as dictated by specified sensor type.
- a. The sensors shall use direct sequence spread spectrum RF technology.

- b. The sensors shall operate on the 2.4 GHZ ISM Band.
 - c. The sensors shall meet the IEEE 802.15.4 standard for low-power, low duty-cycle RF transmitting systems.
 - d. The sensors shall be FCC compliant to CFR Part 15 subpart B Class A.
 - e. The sensors shall be available with:
 - f. Warmer/cooler setpoint adjustment
 - g. No setpoint adjustment
 - h. Setpoint adjustment scale – 55 to 85°F
 - i. Temperature and humidity sensing
 - j. Support for 10K and 3K ohm refrigerator/freezer temperature probe
 - k. Support for NIST rated 3K ohm refrigerator/freezer temperature probe
 - l. Wireless sensors shall be provided with display of room temperature, signal strength, fan mode, occupancy and network status as required by application and indicated on plans or in schedules.
 - m. The sensors shall be assembled in NEMA 1 plastic housings.
5. Provide Johnson Controls ZFR coordinators and routers, with WRZ sensors, or approved equivalents, as shown on plans

G. One-to-One Wireless Room Temperature Sensor System

- 1. The One-To-One Wireless Receiver shall receive wireless RF signals containing temperature data from multiple Wireless Room Temperature Sensors and communicate this information to the appropriate Controller via the SA Bus.
 - a. The Receiver shall use direct sequence spread spectrum RF technology.
 - b. The Receiver shall operate on the 2.4 GHZ ISM Band.
 - c. The Receiver shall meet the IEEE 802.15.4 standard for low power, low duty-cycle RF transmitting systems.
 - d. The Receiver shall be FCC compliant to CFR Part 15 subpart B Class A.
 - e. The Receiver shall operate as a bidirectional transceiver with the sensors to confirm and synchronize data transmission.
 - f. The Receiver shall be capable of communication with from one to five WRZ sensors up to a distance of 200 Feet.
 - g. The Receiver shall be assembled in a plenum rated plastic housing with flammability rated to UL94-5VB.

- h. The Receiver shall have LED indicators to provide information regarding the following conditions:
 - i. Power
 - j. SA Bus – Receiver Activity/No Activity
 - k. Wireless RF – Transmission from sensors/No Transmission
 - l. Wireless Rapid Transmit Mode – No transmission/ weak signal/Adequate signal/Excellent signal
- 2. The Sensors shall sense and report room temperatures to the WRZ Receiver.
 - a. The sensors shall use direct sequence spread spectrum RF technology.
 - b. The sensors shall operate on the 2.4 GHZ ISM Band.
 - c. The sensors shall meet the IEEE 802.15.4 standard for low-power, low duty-cycle RF transmitting systems.
 - d. The sensors shall be FCC compliant to CFR Part 15 subpart B Class A.
 - e. The sensors shall be available with:
 - f. Warmer/cooler setpoint adjustment
 - g. No setpoint adjustment
 - h. Setpoint adjustment scale – 55 to 85°F
 - i. The sensors shall be assembled in NEMA 1 plastic housings.
- 3. Provide Johnson Controls WRZ series Receivers and Sensors, or approved equivalents, as shown on plans.

2.08 AUTOMATION NETWORK

- A. The automation network shall be based on a IT industry standard of Ethernet TCP/IP. Where used, LAN Controller cards shall be standard "off the shelf" products available through normal PC vendor channels.
- B. The DDC system shall network multiple user interface clients, supervisory Controllers, and equipment Controllers. Provide DDC system server as required for systems operation.
- C. All DDC system devices on the automation network shall be capable of operating at a communication speed of 100 Mbps, with full peer-to-peer network communication.
- D. Supervisory Controllers and DDC system server shall reside on the automation network.
- E. The automation network will be compatible with other enterprise-wide networks. Where indicated, the automation network shall be connected to the enterprise network and share resources with it by way of standard networking devices and practices.

2.09 DDC SYSTEM SERVER

- A. Where necessary and as dictated elsewhere in these Specifications, a DDC system Server shall reside on the automation network and be used for the purpose of:
1. Providing a location for extensive archiving of historical data, alarms, and operator transactions sourced from all supervisory Controllers on the automation network.
 2. Centralizing the user interface for all supervisory Controllers on the automation network.
 3. Centralizing the scheduling for all supervisory Controllers on the automation network.
- B. The DDC system server software shall support being hosted on the following computer platforms:
1. Processor: Intel® Xeon® CPU E5-2640, 64-bit (or better), compatible with dual and quad core processors
 2. Operating System: 64-bit: Windows® 10, Windows Server 2012 R2 Standard, Windows Server 2016.
 3. Memory: 6 GB minimum; 8 GB or more recommended for larger systems
 4. Hard Drive: 4 GB minimum, more recommended depending on archiving requirements.
 5. Display: video card and monitor capable of displaying 1024 x 768 pixel resolution or greater.
 6. Network Support: Ethernet adapter (10/100 Mb) with RJ-45 connector)
 7. Connectivity: Always on, high-speed Internet Service Provider (ISP) connection recommended for remote site access (DSL, T1, or cable modem) and IPv6 compliant
- C. The DDC system server shall include an embedded web server to support standard web browser access via the Intranet/Internet. It shall support a minimum of 16 simultaneous users.
- D. The DDC system server shall support the automatic importing of one or more histories from the supervisory Controller(s) for long term archival.
- E. The DDC system server software shall utilize a Java Database Connectivity (JDBC) compatible database such as: MS SQL 8.0, Oracle 8i or IBM DB2. Non-standard and/or proprietary database APIs are not acceptable.
- F. The DDC system server's configuration software shall be embedded into the DDC system server, enabling an authorized user to access the configuration software using a web browser.

2.10 DISTRIBUTED USER INTERFACE(S)

- A. The DDC System shall utilize a distributed, web browser-based, graphical user interface, served up by the supervisory Controller(s) and/or DDC system server.
- B. The distributed user interface shall require user login upon launching the web browser and selecting the appropriate domain name or IP address.
 - 1. Login shall require the user to enter username and strong password and be successfully authenticated.
 - 2. User access and control privileges within the system shall be based on the user's defined role as assigned by the system administrator.
- C. The distributed user interface shall include the following features to allow operators to quickly find information within the system:
 - 1. A home page displaying the following information:
 - a. Image of the building
 - b. Current outside air temperature, today's weather forecast, and tomorrow's weather forecast.
 - c. Links to devices
 - d. Links to schedules
 - e. Links to point summaries
 - 2. A navigation tree listing a hierarchy of system components, including devices and data points.
 - 3. A navigation tree listing a hierarchy of the building's spaces, including any buildings, floors, and rooms, with links to the equipment, devices, and data points serving those spaces.
 - 4. Graphical, floor plan view of the building's spaces, embedded with dynamic links to the views of the equipment, devices, and data points serving those spaces.
- D. The distributed user interface shall provide authorized operators with the following information about each data point in the system database:
 - 1. Identification
 - 2. Present value
 - 3. Status, including normal, overridden, offline, and in alarm.
- E. The distributed user interface shall provide authorized operators a check-the-box method to add alarm, trend, and totalization extensions to any data point in the system.
- F. The distributed user interface shall include the following point summaries to allow operators to quickly view data points that share certain attributes:

1. All point summary
 2. Points-in-alarm summary
 3. Points-in-override summary
 4. Points-offline summary
 5. Non-normal points summary
- G. The distributed user interface shall allow authorized operators to manually command writable data points in the system as part of a 16-level priority write method, defined as:
1. Emergency/Life Safety Manual Command
 2. Automatic Life Safety
 3. User Defined
 4. User Defined
 5. Critical Equipment Control
 6. Minimum On/Off
 7. User Defined
 8. Override (Manual Operator Command)
 9. Demand Limiting
 10. User Defined
 11. Temperature Override
 12. Stop Optimization
 13. Start Optimization
 14. Duty Cycling
 15. Outside Air Optimization
 16. Schedule
- H. The distributed user interface shall allow authorized operators to issue temporary (adjustable time) or permanent manual commands to writable data points in the system.
- I. The distributed user interface shall include an alarm console for authorized users to perform the following alarm management functions:
1. Authorized operators shall be allowed to view all alarms routed to the alarm console, with the following information:
 - a. Time stamp

- b. Source state
 - c. Acknowledge state
 - d. Source
 - e. Alarm class
 - f. Priority
 - g. Message text
2. Authorized operators shall be allowed to apply the following filters to include or exclude alarms shown on the alarm console:
- a. Source state
 - b. Acknowledge state
 - c. Acknowledge required
 - d. Source
 - e. Alarm class
 - f. Priority
 - g. Normal time range
 - h. Acknowledge time range
 - i. User
 - j. Alarm data
 - k. Alarm transition
 - l. Last update time range
3. Authorized operators shall be allowed to acknowledge alarms, either individually or in bulk using the Shift or Ctrl keys.
4. Authorized operators shall be allowed to select an alarm occurrence in the alarm console and link to the view in the system showing the alarm source.
5. Authorized users shall be allowed to add a note to one or more alarm records simultaneously to provide historical context for the event that triggered the alarm.
6. Authorized operators shall be allowed to silence the audible alarm for one or more alarm sources.
- J. The distributed user interface shall include an alarm database maintenance view for authorized users to delete alarm records from the alarm database, but only after the alarms have been acknowledged and the alarm source has returned to a normal (no longer in alarm) state.

- K. The distributed user interface shall include a history chart view for operators to view historical and live data in a chart over time.
 - 1. The distributed user interface shall allow authorized operators to customize the appearance of the history charts in on or more of the following ways:
 - a. Chart type, included any one of the following:
 - 1) Line chart
 - 2) Area chart
 - 3) Bar chart
 - 4) Stacked bar chart
 - 5) Discrete line chart
 - 6) Discrete area chart
 - 7) Pie chart
 - b. X and Y axis range
 - c. Data, background, and status colors
 - d. Axis orientation
 - e. Data source zooming
 - f. Turning the chart grid on/off
 - g. Data popups
- L. The distributed user interface shall allow operators to view multiple data points simultaneously per history chart.
- M. The distributed user interface shall provide a “time zone-less” time range configuration so that operators can plot each history chart with reference to its own time zone, resulting in charts that are aligned by local time.
- N. The distributed user interface shall include a history database maintenance view allowing authorized users to delete history records from the history database.
- O. The distributed user interface shall allow authorized operators to export selected histories as either a table of data in a comma separated variable (*.csv) format or as the selected chart view.
- P. The distributed user interface shall allow authorized operators to view, define, and change the normal, regular, and repeating events in the system schedule using a weekly scheduler view.
- Q. The distributed user interface shall allow authorized operators to view, define, and change partial day exceptions to the system schedule.
- R. The distributed user interface shall include a calendar view to allow operators to define, and change the special events in the system schedule.

2.11 SYSTEM TOOLS

- A. Supervisory Controller Configuration Tool (FX Workbench)

1. The supervisory Controller configuration tool shall be a software package enabling a computer platform to be used as a stand-alone engineering configuration tool for a supervisory Controller or DDC system server.
2. The supervisory Controller configuration tool shall create a station database for the configuration and application data.
3. The supervisory Controller configuration tool shall have the same look-and-feel as the distributed user interface, regardless of whether the configuration is being done online or offline.
4. The supervisory Controller configuration tool shall include the following features:
 - a. System component navigation tree for configured networks
 - b. Integration of BACnet, N2, Lonworks, MODBUS, and supported 3rd party integrated devices
 - c. Configuration of customized user navigation trees
 - d. Graphic view design, layout, and data source binding
 - e. Alarm and event configuration
 - f. Historical data management configuration
 - g. Schedule configuration
 - h. Graphical logic connector tool for custom programming
 - i. Copying, transferring, and archiving databases
5. The supervisory Controller configuration tool shall have the capability to automatically create the following station components for Facility Explorer brand FX-PC Programmable Controllers (FX-PCG, FX-PCA, FX-PCV), Equipment Controllers and Expansion Modules (CV Series, CG Series, XPMs), TEC3000 Network Thermostats, Legacy FX Field Controllers (FX07, FX14, FX16, FXVMA), EM-1000 and EM-2000 Series Electric Meters, and Legacy Facility Explorer Application Specific Controllers (DX-9100, UNT, VMA14xx).
 - a. Devices
 - b. Points
 - c. Default trend, alarm, and totalization extensions
 - d. Graphic views (Px views)

B. Controller Configuration Tool (CCT)

1. As part of the single software tool environment including system and Controller elements, the Controller Configuration Tool (CCT) shall be used to configure, simulate and commission equipment Controllers (For example, the CG Series,

the CV Series, XPMs, PCAs, PCGs, PCVs, and PCXs) and the F4-SNC Supervisory Controller.

2. The CCT shall operate in distinct modes to facilitate efficiency at various steps in the steps leading to project completion as well as future upgrades and maintenance:
 - a. The configuration mode allows users to select various mechanical and control logic options through selection trees for typical air handling, terminal unit, central plant, and VAV applications.
 - b. The simulation mode allows the user to review all application logic as if the device were operating in a connected systems environment.
 - c. The commissioning mode allows users to validate all sensor and control point interfaces and to adjust key setpoints and setup parameters once the device is mounted and connected in an operational environment.
3. The configuration tool shall be capable of programming the equipment Controllers.
 - a. The configuration tool shall provide the capability to configure, simulate, and commission the equipment Controllers.
 - b. The configuration tool shall allow the equipment Controllers to be run in Simulation Mode to verify the applications.
 - c. The configuration tool shall contain a library of standard applications to be used for configuration.
4. The CCT shall provide multiple options for downloading files to the Controllers including direct wired, wireless and Ethernet pass thru as dictated by Controller type and location.
5. Provide Johnson Controls CCT or approve equivalent.

C. System Configuration Tool

1. The Configuration Tool shall be a software package enabling a computer platform to be used as a stand-alone engineering configuration tool for a supervisory Controller.
2. The configuration tool shall provide an archive database for the configuration and application data.
3. The configuration tool shall have the same look-and-feel at the Site Management Portal user interface regardless of whether device configuration is being done online or offline.
4. The configuration tool shall include the following features:
 - a. Basic system navigation tree for connected networks
 - b. Integration of Johnson Controls N1, LonWorks, and BACnet enabled devices

- c. Customized user navigation trees
 - d. Point naming operating parameter setting
 - e. Graphic diagram configuration
 - f. Alarm and event message routing
 - g. Graphical logic connector tool for custom programming
 - h. Downloading, uploading, and archiving databases
5. The configuration tool shall provide a site discovery feature to automatically discover field devices on connected buses and networks. Automatic discovery shall be available for the following field devices:
 - a. BACnet Devices
 6. A wireless access point shall allow a wireless enabled portable PC to make a temporary Ethernet connection to the automation network.
 7. The wireless connection shall allow the PC to access configuration tool through the web browser using the user interface.
 8. The wireless use of configuration tool shall be the same as a wired connection in every respect.
 9. The wireless connection shall use the Bluetooth Wireless Technology.
 10. Provide Johnson Controls SCT or approved equivalent.

2.12 MISCELLANEOUS DEVICES

A. Local Control Panels

1. All control panels shall be factory constructed, incorporating the DDC system manufacturer's standard designs and layouts. All control panels shall be UL inspected and listed as an assembly and carry a UL 508 label listing compliance.
2. Control panels shall be fully enclosed, with perforated sub-panel, hinged door, and slotted flush latch.
3. Control panels shall include keyed lock.
4. In general, the control panels shall consist of the DDC Controller(s), display module as specified and indicated on the plans, and I/O devices—such as relays, transducers, and so forth—that are not required to be located external to the control panel due to function. Where specified the display module shall be flush mounted in the panel face unless otherwise noted.
5. All I/O connections on the DDC Controller shall be provide via removable or fixed screw terminals.

6. Low and line voltage wiring shall be segregated. All provided terminal strips and wiring shall be UL listed, 300-volt service and provide adequate clearance for field wiring.
 7. All wiring shall be neatly installed in plastic trays or tie-wrapped.
 8. A 120 volt convenience outlet, fused on/off power switch, and required transformers shall be provided in each enclosure.
- B. Power Supplies
1. DC power supplies shall be sized for the connected device load. Total rated load shall not exceed 75% of the rated capacity of the power supply.
 2. Input: 120 VAC +10%, 60Hz.
 3. Output: 24 VDC.
 4. Line Regulation: +0.05% for 10% line change.
 5. Load Regulation: +0.05% for 50% load change.
 6. Ripple and Noise: 1 mV rms, 5 mV peak to peak.
 7. An appropriately sized fuse and fuse block shall be provided and located next to the power supply.
 8. A power disconnect switch shall be provided next to the power supply.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
 1. Verify compatibility with and suitability of substrates.
- B. Examine roughing-in for products to verify actual locations of connections before installation.
 1. Examine roughing-in for instruments installed in piping to verify actual locations of connections before installation.
 2. Examine roughing-in for instruments installed in duct systems to verify actual locations of connections before installation.
- C. Examine walls, floors, roofs, and ceilings for suitable conditions where product will be installed.
- D. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 DDC SYSTEM SPECIFIC REQUIREMENTS

A. Graphic Displays

1. Provide a color graphic system flow diagram display for each system with all points as indicated on the point list. All terminal unit graphic displays shall be from a standard design library.
2. User shall access the various system schematics via a graphical penetration scheme and/or menu selection.

B. Custom Reports:

1. Provide custom reports as required for this project

C. Actuation / Control Type

1. Primary Equipment
 - a. Controls shall be provided by equipment manufacturer as specified herein.
 - b. All damper and valve actuation shall be electric.
2. Air Handling Equipment
 - a. All air handlers shall be controlled with a HVAC-DDC Controller
 - b. All damper and valve actuation shall be electric.
3. Terminal Equipment:
 - a. Terminal Units (VAV, UV, etc.) shall have electric damper and valve actuation.
 - b. All Terminal Units shall be controlled with HVAC-DDC Controller)

3.03 INSTALLATION PRACTICES

A. DDC system Wiring

1. All conduit, wiring, accessories and wiring connections required for the installation of the Building Management System, as herein specified, shall be provided by the DDC system Contractor unless specifically shown on the Electrical Drawings under Division 16 Electrical. All wiring shall comply with the requirements of applicable portions of Division 16 and all local and national electric codes, unless specified otherwise in this section.
2. All DDC system wiring materials and installation methods shall comply with DDC system manufacturer recommendations.
3. The sizing, type and provision of cable, conduit, cable trays, and raceways shall be the design responsibility of the DDC system Contractor. If complications arise, however, due to the incorrect selection of cable, cable trays, raceways

and/or conduit by the DDC system Contractor, the Contractor shall be responsible for all costs incurred in replacing the selected components.

4. Class 2 Wiring

- a. All Class 2 (24VAC or less) wiring shall be installed in conduit unless otherwise specified.
- b. Conduit is not required for Class 2 wiring in concealed accessible locations. Class 2 wiring not installed in conduit shall be supported every 5' from the building structure utilizing metal hangers designed for this application. Wiring shall be installed parallel to the building structural lines. All wiring shall be installed in accordance with local code requirements.

5. Class 2 signal wiring and 24VAC power can be run in the same conduit. Power wiring 120VAC and greater cannot share the same conduit with Class 2 signal wiring.

6. Provide for complete grounding of all applicable signal and communications cables, panels and equipment so as to ensure system integrity of operation. Ground cabling and conduit at the panel terminations. Avoid grounding loops.

B. DDC system Line Voltage Power Source

1. 120-volt AC circuits used for the Building Management System shall be taken from panel boards and circuit breakers provided by Division 26.
2. Circuits used for the DDC system shall be dedicated to the DDC system and shall not be used for any other purposes.
3. DDC terminal unit Controllers may use AC power from motor power circuits.

C. DDC system Raceway

1. All wiring shall be installed in conduit or raceway except as noted elsewhere in this specification. Minimum control wiring conduit size 1/2".
2. Where it is not possible to conceal raceways in finished locations, surface raceway (Wiremold) may be used as approved by the Architect.
3. All conduits and raceways shall be installed level, plumb, at right angles to the building lines and shall follow the contours of the surface to which they are attached.
4. Flexible Metal Conduit shall be used for vibration isolation and shall be limited to 3 feet in length when terminating to vibrating equipment. Flexible Metal Conduit may be used within partition walls. Flexible Metal Conduit shall be UL listed.

D. Penetrations

1. Provide fire stopping for all penetrations used by dedicated DDC system conduits and raceways.

2. All openings in fire proofed or fire stopped components shall be closed by using approved fire resistive sealant.
 3. All wiring passing through penetrations, including walls shall be in conduit or enclosed raceway.
 4. Penetrations of floor slabs shall be by core drilling. All penetrations shall be plumb, true, and square.
- E. DDC system Identification Standards
1. Node Identification. All nodes shall be identified by a permanent label fastened to the enclosure. Labels shall be suitable for the node location.
 2. Cable types specified in Item A shall be color coded for easy identification and troubleshooting.
- F. DDC system Panel Installation
1. The DDC system panels and cabinets shall be located as indicated at an elevation of not less than 2 feet from the bottom edge of the panel to the finished floor. Each cabinet shall be anchored per the manufacturer's recommendations.
 2. The DDC system Contractor shall be responsible for coordinating panel locations with other trades and electrical and mechanical contractors.
- G. Input Devices
1. All Input devices shall be installed per the manufacturer recommendation
 2. Locate components of the DDC system in accessible local control panels wherever possible.
- H. HVAC Input Devices – General
1. All Input devices shall be installed per the manufacturer recommendation
 2. Locate components of the DDC system in accessible local control panels wherever possible.
 3. The mechanical contractor shall install all in-line devices such as temperature wells, pressure taps, airflow stations, etc.
 4. Input Flow Measuring Devices shall be installed in strict compliance with ASME guidelines affecting non-standard approach conditions.
 5. Outside Air Sensors
 - a. Sensors shall be mounted on the North wall to minimize solar radiant heat impact or located in a continuous intake flow adequate to monitor outside air conditions accurately.
 - b. Sensors shall be installed with a rain proof, perforated cover.
 6. Water Differential Pressure Sensors

- a. Differential pressure transmitters used for flow measurement shall be sized to the flow-sensing device.
 - b. Differential pressure transmitters shall be supplied with tee fittings and shut-off valves in the high and low sensing pick-up lines.
 - c. The transmitters shall be installed in an accessible location wherever possible.
7. Medium to High Differential Water Pressure Applications (Over 21" w.c.):
- a. Air bleed units, bypass valves and compression fittings shall be provided.
8. Building Differential Air Pressure Applications (-1" to +1" w.c.):
- a. Transmitters exterior sensing tip shall be installed with a shielded static air probe to reduce pressure fluctuations caused by wind.
 - b. The interior tip shall be inconspicuous and located as shown on the drawings.
9. Air Flow Measuring Stations:
- a. Where the stations are installed in insulated ducts, the airflow passage of the station shall be the same size as the inside airflow dimension of the duct.
 - b. Station flanges shall be two inch to three inch to facilitate matching connecting ductwork.
10. Duct Temperature Sensors:
- a. Duct mount sensors shall mount in an electrical box through a hole in the duct and be positioned so as to be easily accessible for repair or replacement.
 - b. The sensors shall be insertion type and constructed as a complete assembly including lock nut and mounting plate.
 - c. For ductwork greater in any dimension than 48 inches or where air temperature stratification exists such as a mixed air plenum, utilize an averaging sensor.
 - d. The sensor shall be mounted to suitable supports using factory approved element holders.
11. Space Sensors:
- a. Shall be mounted per ADA requirements.
 - b. Provide lockable tamper-proof covers in public areas and/or where indicated on the plans.
12. Low Temperature Limit Switches:

- a. Install on the discharge side of the first water or steam coil in the air stream.
 - b. Mount element horizontally across duct in a serpentine pattern insuring each square foot of coil is protected by 1 foot of sensor.
 - c. For large duct areas where the sensing element does not provide full coverage of the air stream, provide additional switches as required to provide full protection of the air stream.
13. Air Differential Pressure Status Switches:
- a. Install with static pressure tips, tubing, fittings, and air filter.
14. Water Differential Pressure Status Switches:
- a. Install with shut off valves for isolation.
15. HVAC Output Devices
- a. All output devices shall be installed per the manufacturers recommendation. The mechanical contractor shall install all in-line devices such as control valves, dampers, airflow stations, pressure wells, etc.
 - b. Actuators: All control actuators shall be sized capable of closing against the maximum system shut-off pressure. The actuator shall modulate in a smooth fashion through the entire stroke. When any pneumatic actuator is sequenced with another device, pilot positioners shall be installed to allow for proper sequencing.
 - c. Control Dampers: Shall be opposed blade for modulating control of airflow. Parallel blade dampers shall be installed for two position applications.
 - d. Control Valves: Shall be sized for proper flow control with equal percentage valve plugs. The maximum pressure drop for water applications shall be 5 PSI. The maximum pressure drop for steam applications shall be 7 PSI.
 - e. Electronic Signal Isolation Transducers: Whenever an analog output signal from the Building Management System is to be connected to an external control system as an input (such as a chiller control panel), or is to receive as an input a signal from a remote system, provide a signal isolation transducer. Signal isolation transducer shall provide ground plane isolation between systems. Signals shall provide optical isolation between systems

3.04 TRAINING

- A. Provide 40 hours of training for owner's personnel which shall include the following:
 - 1. Layman's description of the HVAC/control system
 - 2. Location of all key control devices (such as, panels, override switches, etc.)

3. Operational training

- B. The initial training shall be given when the system is operational and has been verified completed by the Engineer. Follow-up sessions will be scheduled as needed by the School Principal during the 1-year warranty period.
- C. Training hours are to be recorded on a log sheet to be prepared by the trainer and given to the Owner at the initial training session. Each subsequent training event is to be entered into the log and initialed by both the trainer and the trainee with a brief description of the instruction given.

3.05 COMMISSIONING

- A. Fully commission all aspects of the Building Management System work.
- B. Acceptance Check Sheet
 - 1. Prepare a check sheet that includes all points for all functions of the DDC system as indicated on the point list included in this specification.
 - 2. Submit the check sheet to the Engineer for approval
 - 3. The Engineer will use the check sheet as the basis for acceptance with the DDC system Contractor.
- C. VAV box performance verification and documentation:
 - 1. The DDC system Contractor shall test each VAV box for operation and correct flow. At each step, after a settling time, box air flows and damper positions will be sampled. Following the tests, a pass/fail report indicating results shall be produced. Possible results are Pass, No change in flow between full open and full close, Reverse operation or Maximum flow not achieved. The report shall be submitted as documentation of the installation.
 - 2. The DDC system Contractor shall issue a report based on a sampling of the VAV calculated loop performance metrics. The report shall indicate performance criteria, include the count of conforming and non-conforming boxes, list the non-conforming boxes along with their performance data, and shall also include graphical representations of performance.
- D. Promptly rectify all listed deficiencies and submit to the Engineer that this has been done.

3.06 RECORD DOCUMENTS

- A. Provide operation and maintenance manuals.
- B. Furnish and install plastic encased charts and flow diagrams in each equipment room.
- C. Provide one copy of the control system record drawings, submitted as part of the project close-out package. Submission shall be in AutoCAD format on disk (no paper copies), to include the following information:
 - 1. Point-to-point wiring diagrams and sequences of operation.

2. Location on the drawings of critical control devices such as control panels, auxiliary control panels, static pressure sensors, room temperature sensors, water temperature sensors/wells.
3. Location of all 120/1/60 power sources for the control devices.
4. Control valve sizing (valve CV and pressure drops). Valve schedules.
5. Complete bill of material.
6. Room schedule.
7. Phone line or internet location for remote system access.
8. Homerun connections between panels.
9. Communication trunk line layouts.
10. Lightning protection devices (quantity and location).
11. Surge protection devices (quantity and location).

3.07 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

END OF SECTION 23 09 23

SECTION 23 09 23.13
ACTUATORS AND OPERATORS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00.
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) requirements.

1.03 SUMMARY

- A. Section includes control actuators and for DDC systems.
- B. Related Requirements:
 - 1. Section 23 09 23 “Direct-Digital Control System for HVAC” for control equipment and software, relays, electrical power devices, uninterruptible power supply units, wire, and cable.

1.04 DEFINITIONS

- A. DDC: Direct-digital control.

1.05 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings:
 - 1. Include mounting details.
 - 2. Include details of product assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Include diagrams for power, signal, and control wiring.

1.06 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For control dampers to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. 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.
- B. Ground Fault: Products shall not fail due to ground fault condition when suitably grounded.

2.02 ACTUATORS AND OPERATORS

A. General Requirements

- 1. Actuators shall be electronic or pneumatic, or both, as detailed in the following sections.
- 2. The manufacturer shall be ISO 9001 certified.

B. Electronic Damper Actuators

1. Spring Return Actuators:

- a. Spring Return Actuators shall be manufactured, brand labelled and distributed by Johnson Controls or an approved equivalent.
- b. Regulatory Agency Listing: cULus ,CSA C22.2 No. 24-93, and CE marked
- c. Direct-Coupled Design: Requires no crankarm or linkage for mounting to a shaft.
- d. Coupling: toothed V-bolt clamp and nuts with toothed cradle.
- e. Reversible Mounting: Provides either clockwise or counterclockwise operation.
- f. Power Failure Operation: Mechanical spring return system drives load to the home position. Other forms of internal energy storage for power failure operation are not acceptable
- g. Spring Return Actuators shall utilize the following motor technology:
 - 1) Modulating types: Microprocessor-controlled brushless DC motors
 - 2) On/Off types: DC brush motor
- h. Spring Return Actuators shall comply with enclosure ratings of NEMA type 2 or IP54 mounted in any orientation.
- i. Spring Return Actuators shall eliminate the need for electrical ground wires for double-insulated construction.
- j. Spring Return Actuators shall be furnished with integral cables with colored and numbered conductors for simplified wiring.

- k. Spring Return Actuators shall be sized for the torque required to seal the damper at load conditions.
- l. Spring Return Actuators shall be available in parallel operation that are capable of being mechanically or electrically paralleled.
- m. Proportional actuators shall be user configurable without the use of external computer software or programming tools. Calibration, input signal range selection, and control logic reversal shall be selectable with an external mode selection switch.
- n. Spring Return Actuators shall operate in the following temperature ranges:
 - 1) For a 70 lb·in. torque actuator range must be -40°F to 140°F (-40°C to 60°C)
 - 2) For a 177 lb·in. torque actuator range must be -40°F to 131°F (-40°C to 55°C)
- o. Spring Return Actuators shall be provided with the following power requirements:
 - 1) Modulating types:
 - a) 27 lb·in. torque and below: 5VA maximum
 - b) 70 lb·in. to 19 lb·in.torque: has a 8VA maximum
 - c) 89 lb·in. to 71 lb·in.torque: has a 10VA maximum
 - d) 90 lb·in. to 177 lb·in.torque: has a 16VA maximum
 - 2) Two-position types:
 - a) 27 lb·in. torque and below: has a 5VA maximum
 - b) 70 lb·in. to 19 lb·in.torque: has a 7VA maximum
 - c) 71 lb·in. to 177 lb·in.torque: has a 25VA maximum

2. Non-Spring Return Actuators

- a. Non-Spring Return (NSR) actuators shall be manufactured, brand labelled or distributed by Johnson Controls or an approved equivalent. The NSR actuators are manufactured under International Standards Organization (ISO) 9001 Quality Control Standards to ensure quality.
- b. NSR actuators shall comply with the following regulatory agency listings: cULus, CSA C22.2 No 24-93, and CE marked. APAC actuators are excluded from this regulatory information.
- c. NSR actuators shall be provided with a 5 year warranty from the date of sale covering defects in material or workmanship. .
- d. Actuators sold in the APAC region shall comply with an 18 month warranty policy.
- e. NSR actuators shall be of direct-coupled design and require no crank arm or linkage for mounting to a shaft.

- f. NSR actuators shall be of a design that converts the damper version to the valve version without the use of special tools.
- g. NSR actuators shall be configured for direct mounting and will not require any damper linkage. Actuators can be mounted directly with a universal clamp to the following:
 - 1) Round damper shaft from 3/8 in. (10mm) up to 1 in. to 1/16 in. (27mm)
 - 2) Square damper shaft from 3/8 in. (10mm) up to 3/4 in. (19mm)
- h. NSR actuators shall offer multiple shaft coupling methods:
 - 1) For units above 80 lb-in a toothed V-bolt clamp and nuts with a toothed cradled shall be used
 - 2) For units 80 lb-in. and below use a single-cup-point set screw and toothed cradle shall be used
- i. NSR actuators shall be furnished with a Minimum IP (ingress protection) enclosure ratings as follows:
 - 1) Actuator for types with covered wiring terminals shall be furnished as NEMA type 2/IP42 mounted in any orientation.
 - 2) Actuators for types without a covered wiring terminal shall be furnished with a NEMA type 1/IP30 or IP40.
 - 3) Actuators for types with integrated cables shall be furnished as NEMA type 2/IP42 mounted in any orientation.
 - 4) NSR actuators shall be furnished with a minimum IP (ingress protection) rating of no lower than IP42, but also be available in NEMA5/IP54.
- j. NSR actuators shall be able to operable in a temperature range of -4°F to 122°F (-20°C to 50°C) except for VAV and similar indoor applications in which 32°F to 122°F (0°C to 50°C) is acceptable.
- k. NSR actuators shall be sized for the torque required to seal the damper at load conditions. For NSR actuators in parallel operation, actuators shall be available that are capable of being mechanically or electrically paralleled automatically
- l. NSR proportional actuators shall be user configurable without requiring the use of external computer software or programming tools.
- m. NSR actuators shall be provided with the following power requirements:
 - 1) 24 V with models available for both 24 VAC and 24 VDC operation (maximum)
 - 2) For NSR actuators above 80 lb-in. a maximum of 7.5 VA at 24 VAC
 - 3) For NSR actuators 80 lb-in. or below a maximum of 3.5 VA at 24 VAC

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for dampers and instruments installed in duct systems to verify actual locations of connections before installation.
- C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION, GENERAL

- A. Furnish and install products required to satisfy most stringent requirements indicated.
- B. Properly support actuators, tubing, wiring, and conduit to comply with requirements indicated. Brace all products to prevent lateral movement and sway or a break in attachment when subjected to a force.
- C. Provide ceiling, floor, roof, and wall openings and sleeves required by installation. Before proceeding with drilling, punching, or cutting, check location first for concealed products that could potentially be damaged. Patch, flash, grout, seal, and refinish openings to match adjacent condition.
- D. Seal penetrations made in fire-rated and acoustically rated assemblies.
- E. Fastening Hardware:
 - 1. Stillson wrenches, pliers, or other tools that will cause injury to or mar surfaces of rods, nuts, and other parts are prohibited for assembling and tightening nuts.
 - 2. Tighten bolts and nuts firmly and uniformly. Do not overstress threads by excessive force or by oversized wrenches.
 - 3. Lubricate threads of bolts, nuts, and screws with graphite and oil before assembly.
- F. Install products in locations that are accessible and that will permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner's access, confirm unrestricted ladder placement is possible under occupied condition.
- G. Corrosive Environments:
 - 1. Use products that are suitable for environment to which they will be subjected.
 - 2. If possible, avoid or limit use of materials in corrosive environments, including, but not limited to, the following:
 - a. Salt water environment.

3. Use Type 316 stainless-steel tubing and fittings when in contact with a corrosive environment.
4. When conduit is in contact with a corrosive environment, use Type 316 stainless-steel conduit and fittings or conduit and fittings that are coated with a corrosive-resistant coating that is suitable for environment.
5. Where actuators are located in a corrosive environment and are not corrosive resistant from manufacturer, field install products in a NEMA 250, Type 4X enclosure constructed of Type 316L stainless steel.

3.03 ELECTRIC POWER

- A. Furnish and install electrical power to products requiring electrical connections.
- B. Furnish and install circuit breakers. Comply with requirements in Section 26 28 16 “Enclosed Switches and Circuit Breakers.”
- C. Furnish and install power wiring. Comply with requirements in Section 26 05 19 “Low-Voltage Electrical Power Conductors and Cables.”
- D. Furnish and install raceways. Comply with requirements in Section 26 05 33 “Raceways and Boxes for Electrical Systems.”

3.04 CONTROL DAMPERS

- A. Install smooth transitions, not exceeding 15 degrees, to dampers smaller than adjacent duct. Install transitions as close to damper as possible but at distance to avoid interference and impact to performance. Consult manufacturer for recommended clearance.
- B. Clearance:
 1. Locate dampers for easy access and provide separate support of dampers that cannot be handled by service personnel without hoisting mechanism.
 2. Install dampers with at least 24 inches of clear space on sides of dampers requiring service access.
- C. Service Access:
 1. Dampers and actuators shall be accessible for visual inspection and service.
 2. Install access door(s) in duct or equipment located upstream of damper to allow service personnel to hand clean any portion of damper, linkage, and actuator. Comply with requirements in Section 23 33 00 “Air Duct Accessories.”
- D. Install dampers straight and true, level in all planes, and square in all dimensions. Install supplementary structural steel reinforcement for large multiple-section dampers if factory support alone cannot handle loading.
- E. Attach actuator(s) to damper drive shaft.
- F. For duct-mounted and equipment-mounted dampers installed outside of equipment, install a visible and accessible indication of damper position from outside.

3.05 CONNECTIONS

- A. Connect electrical devices and components to electrical grounding system. Comply with requirements in Section 26 05 26 “Grounding and Bonding for Electrical Systems.”

3.06 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Each piece of wire, cable, and tubing shall have the same designation at each end for operators to determine continuity at points of connection. Comply with requirements for identification specified in Section 26 05 53 “Identification for Electrical Systems.”
- B. Install engraved phenolic nameplate with damper identification on damper and on face of ceiling where damper is concealed above ceiling.

3.07 CHECKOUT PROCEDURES

- A. Checkout:
 - 1. Check installed products before continuity tests, leak tests, and calibration.
 - 2. Verify that actuator and linkage attachment are secure.
 - 3. Verify that actuator wiring is complete, enclosed, and connected to correct power source.

3.08 ADJUSTMENT, CALIBRATION, AND TESTING:

- A. Check and document open and close cycle times for applications with a cycle time of less than 30 seconds.

END OF SECTION 23 09 23.13

SECTION 23 09 23.23
SENSORS AND TRANSMITTERS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00.
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) requirements.

1.03 SUMMARY

- A. Section Includes:
 - 1. Temperature sensors.
 - 2. Humidity sensors.
 - 3. CO2 sensors.
 - 4. Differential pressure transmitters.
 - 5. Flow monitoring.
 - 6. Power monitoring.
 - 7. Refrigerant leak detectors.
 - 8. Smoke detectors.
 - 9. Switches.
 - 10. Relays.
 - 11. Transducers.
- B. Related Requirements:
 - 1. Section 23 09 23 “Direct-Digital Control System for HVAC” for control equipment and software, relays, electrical power devices, uninterruptible power supply units, wire, and cable.

1.04 DEFINITIONS

- A. HART (Highway Addressable Remote Transducer) Protocol: The global standard for sending and receiving digital information across analog wires between smart devices and

control or monitoring systems through bidirectional communication that provides data access between intelligent field instruments and host systems. A host can be any software application from a technician's hand-held device or laptop to a plant's process control, asset management, safety, or other system using any control platform.

1.05 ACTION SUBMITTALS

- A. Product Data: For each type of product, including the following:
 - 1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes.
 - 2. Operating characteristics, electrical characteristics, and furnished accessories indicating process operating range, accuracy over range, control signal over range, default control signal with loss of power, calibration data specific to each unique application, electrical power requirements, and limitations of ambient operating environment, including temperature and humidity.
 - 3. Product description with complete technical data, performance curves, and product specification sheets.
 - 4. Installation operation and maintenance instructions, including factors affecting performance.
- B. Shop Drawings:
 - 1. Include plans, elevations, sections, and mounting details.
 - 2. Include details of product assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Include diagrams for power, signal, and control wiring.
 - 4. Include number-coded identification system for unique identification of wiring, cable, and tubing ends.
- C. Samples: For each exposed product installed in finished space.

1.06 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Plan drawings and corresponding product installation details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Product installation location shown in relationship to room, duct, pipe, and equipment.
 - 2. Wall-mounted instruments located in finished space showing relationship to light switches, fire-alarm devices, and other installed devices.
 - 3. Sizes and locations of wall access panels for instruments installed behind walls.

- 4. Sizes and locations of ceiling access panels for instruments installed in inaccessible ceilings.
- B. Product Certificates: For each product requiring a certificate.
- C. Field quality-control reports.

PART 2 - PRODUCTS

2.01 SENSORS AND TRANSMITTERS AND MONITORING

A. General Requirements

- 1. Installation, testing, and calibration of all sensors, transmitters, and other input devices shall be provided to meet the system requirements. Exact OEM equivalents of specified sensors and transmitters shall be acceptable if clearly identified in submittals.

B. Temperature Sensors

1. General Requirements

- a. Sensors and transmitters shall be provided, as outlined in the input/output summary and sequence of operations.
- b. The temperature sensor shall be of the resistance type, and shall be either two-wire 1000 ohm nickel RTD, or two-wire 1000 ohm platinum RTD. Thermistor sensors of 10,000 or 2,250 ohms resistance may be substituted based on the application.
- c. The following point types (and the accuracy of each) are required, and their associated accuracy values include errors associated with the sensor, lead wire, and A to D conversion.

Point Type	Accuracy
Chilled Water	+ .5°F
Room Temp	+ .5°F
Duct Temperature	+ .5°F
All Others	+ .75°F

2. Room Temperature Sensors

- a. Room sensors shall be constructed for either surface or wall box mounting.
- b. Room sensors shall have the following options when specified:
 - 1) Setpoint warmer/cooler
 - 2) Individual heating/cooling setpoint
 - 3) Momentary override request for activation of after-hours operation
 - 4) Analog thermometer

3. Room Temperature Sensors with Integral Display

- a. Room sensors shall be constructed for either surface or wall box mounting.
 - b. Room sensors shall have an integral LCD display and the following capabilities when specified:
 - 1) Display room air temperatures
 - 2) Display and adjust room comfort setpoint
 - 3) Display and adjust fan operation status
 - 4) Setpoint override request via setpoint adjust dial or buttons
 - 5) Timed override request via occupancy override with status indication for activation of after-hours setpoint operation
 - 6) Occupancy sensor status
 - 7) Toggle between Degrees F and Degrees C
 - 8) Toggle between temperature and humidity where specified
4. Thermowells
- a. Thermowell manufacturer shall have models available in stainless steel, brass body, and copper bulb.
 - b. When thermowells are required, the sensor and well shall be supplied as a complete assembly, including wellhead and sensor.
 - c. Thermowells shall be pressure rated and constructed in accordance with the system working pressure.
 - d. Thermowells and sensors shall be mounted in a direct mount (no adapter) offering faster installation or 1/2" NPT saddle and allow easy access to the sensor for repair or replacement.
 - e. Thermowells constructed of 316 stainless steel shall comply with Canadian Registration Number (CRN) pressure vessel rating.
5. Outside Air Sensors
- a. Outside air sensors shall be designed to withstand the environmental conditions to which they will be exposed. They shall be provided with a solar shield.
 - b. Sensors exposed to wind velocity pressures shall be shielded by a perforated plate that surrounds the sensor element.
 - c. Temperature transmitters shall be of NEMA 3R (IP54) or NEMA 4 (IP65) construction and rated for ambient temperatures.
 - d. The outdoor sensor shall be capable of being mounted on a roof, pole or side of a building utilizing its preassembled mounting bracket.
 - e. Outside air relative humidity sensors 0-100% full range of accurate measurement. Operating temperature -4 to 140°F (-20 to 60°C).
 - f. Outside air temperature sensors operating temperature range -40 to 140°F, +/- .55°F (+/- .3°C).

6. Duct Mount Sensors
 - a. Duct mount sensors shall mount in an electrical box through a hole in the duct, positioned to provide ease of accessibility for repair or replacement.
 - b. Duct sensors shall be insertion type and constructed as a complete assembly, including lock nut and mounting plate.
 - c. For outdoor air duct applications, a weatherproof mounting box with weatherproof cover and gasket shall be provided.
7. Averaging Sensors
 - a. For ductwork greater in any dimension than 48 inches and/or where air temperature stratification exists, an averaging sensor with multiple sensing points shall be used.
 - b. For plenum applications, such as mixed air temperature measurements, a continuous averaging sensor or a string of sensors mounted across the plenum shall be used to account for stratification and/or air turbulence. The averaging string shall have a minimum of 4 sensing points per 12-foot long segment.
 - c. Capillary supports at the sides of the duct shall be provided to support the sensing string.
8. Acceptable Manufacturers: Johnson Controls, Minco.

C. Humidity Sensors

1. The sensor shall be a solid-state type, relative humidity sensor of the Thin Film Capacitance or Bulk Polymer Design. The sensor element shall resist service contamination.
2. The humidity transmitter shall be equipped with non-interactive span and zero adjustments, a 2-wire isolated loop powered, 4-20 mA, 0-100% linear proportional output.
3. The humidity transmitter shall meet the following overall accuracy, including lead loss and Analog to Digital conversion. 3% between 20% and 80% RH at 77°F unless specified elsewhere.
4. Outside air relative humidity sensors shall be installed with a rain proof, perforated cover. The transmitter shall be installed in a NEMA 3R (IP54) or NEMA 4 (IP65) enclosure with sealtite fittings.
5. A single point humidity calibrator shall be provided, if required, for field calibration. Transmitters shall be shipped factory pre-calibrated.
6. Duct type sensing probes shall be constructed of 304 stainless steel, and shall be equipped with a neoprene grommet, bushings, and a mounting bracket.
7. Acceptable Manufacturers: Johnson Controls, Greystone, and Vaisala.

D. CO2 Sensors

1. Where shown on the drawings, CO2 sensors shall have the following features:
 - a. Jumper selectable: 0-20mA, 4-20mA & 0-10 VDC output
 - b. Liquid Crystal Display (LCD)
2. The CO2 sensors shall have the ability to monitor and output the following variables as required by the systems sequence of operations:
 - a. Zone CO2
3. The CO2 shall transmit the information back to the Controller via jumper selectable 0-20mA, 4-20mA & 0-10 VDC output signals:
 - a. The CO2 sensors shall provide a maximum output current of 25mA; Maximum output voltage of 12.5V.
 - b. The CO2 sensors shall be FCC compliant to CFR47 Part 15 subpart B Class A.
4. The CO2 sensors shall be available with:
 - a. CO2 response time (0-63%) of 1 minute
 - b. Less than 0.083% of full scale/°F temperature dependence of CO2 output
 - c. Long term CO2 stability $\pm 5\%$ of full scale for 5 years
 - d. CO2 measurement accuracy of $\pm(40\text{ppm} + 2.0\%$ of reading)
 - e. CO2 non-linearity of less than 1.0% of full scale
5. The CO2 sensors may include the following items:
 - a. Relay output module
 - b. LCD module
 - c. Analog temperature module with linear 0-10 VDC output for 32-122F

E. Differential Pressure Transmitters

1. General Air and Water Pressure Transmitter Requirements:
 - a. Pressure transmitters shall be constructed to withstand 100% pressure over-range without damage, and to hold calibrated accuracy when subject to a momentary 40% over-range input.
 - b. Pressure transmitters shall transmit a 0 to 5 VDC, 0 to 10 VDC, or 4 to 20 mA output signal.
 - c. Differential pressure transmitters used for flow measurement shall be sized to the flow sensing device, and shall be supplied with Tee fittings

and shut-off valves in the high and low sensing pick-up lines to allow the balancing Contractor and Owner permanent, easy-to-use connection.

- d. A minimum of a NEMA 1 housing shall be provided for the transmitter. Transmitters shall be located in accessible local control panels wherever possible.
 - e. Low Differential Water Pressure Applications (0" - 20" WC):
 - f. The differential pressure transmitter shall be of industrial quality and transmit a linear, 4 to 20 mA output in response to variation of flow meter differential pressure or water pressure sensing points.
 - g. The differential pressure transmitter shall have non-interactive zero and span adjustments that are adjustable from the outside cover and meet the following performance specifications:
 - 1) .01-20" WC input differential pressure range
 - 2) 4-20 mA output
 - 3) Maintain accuracy up to 20 to 1 ratio turndown
 - 4) Reference Accuracy: +0.2% of full span
 - h. Acceptable Manufacturers: Setra and Mamac.
2. Medium to High Differential Water Pressure Applications (Over 21" WC):
- a. The differential pressure transmitter shall meet the low-pressure transmitter specifications with the following exceptions:
 - 1) Differential pressure range 10" WC to 300 PSI
 - 2) Reference Accuracy: +1% of full span (includes non-linearity, hysteresis, and repeatability)
 - b. Standalone pressure transmitters shall be mounted in a bypass valve assembly panel. The panel shall be constructed to NEMA 1 standards. The transmitter shall be installed in the panel with high and low connections piped and valved. Air bleed units, bypass valves, and compression fittings shall be provided.
 - c. Acceptable Manufacturers: Setra and Mamac.
3. Building Differential Air Pressure Applications (-1" to +1" WC):
- a. The differential pressure transmitter shall be of industrial quality and transmit a linear, 4 to 20 mA output in response to variation of differential pressure or air pressure sensing points.
 - b. The differential pressure transmitter shall have non-interactive zero and span adjustments that are adjustable from the outside cover and meet the following performance specifications:
 - 1) -1.00 to +1.00 WC input differential pressure ranges. (Select range appropriate for system application)
 - 2) 4-20 mA output

- 3) Maintain accuracy up to 20 to 1 ratio turndown
 - 4) Reference Accuracy: +0.2% of full span
 - 5) Acceptable Manufacturers: Johnson Controls or approved equal
4. Low Differential Air Pressure Applications (0" to 2.5" WC):
- a. The differential pressure transmitter shall be of industrial quality and transmit a linear, 4 to 20 mA output in response to variation of differential pressure or air pressure sensing points.
 - b. The differential pressure transmitter shall have non-interactive zero and span adjustments that are adjustable from the outside cover and meet the following performance specifications.
 - 1) (0.00 - 1.00" to 5.00") WC input differential pressure ranges (select range appropriate for system application)
 - 2) 4-20 mA, 0-5 VDC, 0-10 VDC output
 - 3) Maintain accuracy up to 20/1 ratio turndown
 - 4) Reference Accuracy: +0.25%, or 0.5% of full span
 - c. Acceptable Manufacturers: Johnson Controls and Ruskin
5. Medium Differential Air Pressure Applications (5" to 21" WC):
- a. The pressure transmitter shall be similar to the Low Air Pressure Transmitter, except that the performance specifications are not as severe. Differential pressure transmitters shall be provided that meet the following performance requirements.
 - 1) Zero & span: (c/o F.S./Deg. F): .04% including linearity, hysteresis and repeatability
 - 2) Accuracy: 1% F.S. (best straight line) Static Pressure Effect: 0.5% F.S. (to 100 psig.)
 - 3) Thermal Effects: <+.033 F.S./Deg. F. over 40°F to 100°F (calibrated at 70°F.)
 - b. Standalone pressure transmitters shall be mounted in a bypass valve assembly panel. The panel shall be constructed to NEMA 1 standards. The transmitter shall be installed in the panel with high and low connections piped and valved. Air bleed units, bypass valves, and compression fittings shall be provided.
 - c. Acceptable manufacturers: Johnson Controls and Ruskin

F. Flow Monitoring

1. Air Flow Monitoring

a. Fan Inlet Air Flow Measuring Stations

- 1) At the inlet of each fan and near the exit of the inlet sound trap, airflow sensors shall be provided that shall continuously monitor the fan air volumes or velocity pressure.

- 2) Each sensor shall be surface mount type. Unit shall be capable of monitoring and reporting the airflow and temperature at each fan inlet location through two or four sensing circuits. If a static pressure manifold is used, it shall incorporate dual offset static tips on the opposing sides of the averaging manifold so as to be insensitive to flow-angle variations of as much as + 20° in the approaching air stream.
- 3) Devices creating fan performance degradation, resulting in additional energy consumption, caused from pressure drop associated with probes or mounting apparatus in the center of the fan inlet are not allowed. The device shall not induce a significant pressure drop, nor shall the sound level within the duct be amplified by its singular or multiple presence in the air stream. Sensor circuit casings shall be constructed of U.L. 94 flame rated high impact ABS and include a stainless steel thermistor cap that maintains the precise calibrated flow over the heated and ambient measurement points.
- 4) Acceptable manufacturers: Johnson Controls, Air Monitor Corp., Tek-Air Systems, Inc., or Dietrich Standard

b. Single Probe Air Flow Measuring Sensor

- 1) The single probe airflow-measuring sensor shall be duct mounted with an adjustable sensor insertion length of up to eight inches. The transmitter shall produce a 4-20 mA or 0-10 VDC signal linear to air velocity. The sensor shall be a thermal dispersion and utilize one temperature sensor and a heated thermistor. The sensor pair shall measure the air temperature and airflow velocity.

c. Duct Air Flow Measuring Stations

- 1) Furnish and install, at locations shown on plans or as in accordance with schedules, an equalized air measuring probe system piped to a high performance pressure transducer or an electronic type airflow temperature measuring station.
- 2) Each device shall be designed and built in order to comply with, and provide results in accordance with, accepted practice as defined for system testing in the ASHRAE Handbook of fundamentals, as well as in the Industrial Ventilation Handbook.
- 3) Assembly shall be AMCA tested and capable of measuring a range from 70 to 5,000 FPM (22 to 1524 MPM).
- 4) Equalized air measuring assembly shall measure to $\pm 3\%$ average and consist of 6063T5 extruded aluminum step sensing blade(s) with anodized finish, plenum-rated polyethylene pressure tubing, brass barbed fittings, mounting hardware and a glass-on-silicone capacitance sensor pressure transducer capable of measuring up to five field-selectable pressure ranges up to 2.5 in. WC.
- 5) The transducer shall be accurate to $\pm 0.5\%$, or 0.25% of full scale and be contained in a National Electrical Manufacturer's Association (NEMA) 4 (IP-65) enclosure. Transducer shall be factory mounted and piped to high and low pressure ports through fittings made of brass.
- 6) All sensor tubing shall terminate in solid brass barbed fittings.

- 7) Total and static pressure manifolds shall terminate with external ports for connection to control tubing. An identification label shall be present on each unit casing, listing model number, size, area, and airflow capacity.
- 8) Air straightener shall be provided for sizes over 17 square feet (1.6 sq meter).
- 9) Airflow measuring station assemblies shall be fabricated of galvanized steel or aluminum casing of appropriate thickness for slip fits or with 90 Deg. connecting flanges in configuration and size equal to that of the duct into which it is mounted. Each station shall be complete with an air directionalizer and parallel cell profile suppressor (3/4" maximum cell) across the entering air stream and mechanically fastened to the casing in such a way to withstand velocities up to 5000 feet per minute.
- 10) Equalized air measuring probe assemblies shall be, in all respects, equivalent to Johnson Controls® AD-1250 or AD-1251 airflow measuring systems.
- 11) Electronic air measuring station shall be capable of monitoring and reporting the airflow and temperature at each measuring location through one or more measuring probes containing multiple sensor points and a control transmitter that outputs a 4-20 mA linear signal.
- 12) Probe(s) shall be constructed of an airfoil shaped aluminum extrusion containing the sensor circuit(s).
- 13) Each sensor circuit shall consist of coated thermistors, for temperature and velocity, mounted to a Printed Circuit Board (PCB). Multiplexer board shall be encased to prevent moisture damage.
- 14) Shielded CAT5e communications cable shall be Underwriters Laboratories Inc.® (UL) plenum-rated with RJ45 terminal connectors. Dust boot covers and gold-plated contacts shall link probes to electronic Controller.
- 15) Control transmitter shall be capable of processing independent sensing points and shall operate on a fused 24 VAC supply.
- 16) Control transmitter shall feature a 16 x 2 character alphanumeric LCD screen, digital offset/gain adjustment, continuous performing sensor/transmitter diagnostics, and a visual alarm to detect malfunctions.
- 17) All electronic components of the assembly shall be Restriction of Hazardous Substances (RoHS) Directive compliant equal to Johnson Controls AD-1252.
- 18) Installation Considerations
 - a) The maximum allowable pressure loss through the Flow and Static Pressure elements shall not exceed .04" WC at 1000 feet per minute, or .11" WC at 2000 feet per minute. Each unit shall measure the airflow rate within an accuracy of plus 3-5% as determined by AMCA.
 - b) Where the stations are installed in insulated ducts, the airflow passage of the station shall be the same size as the inside airflow dimension of the duct. Station flanges shall be 1.5 inches to facilitate matching connecting ductwork.
 - c) Where control dampers are provided as part of the airflow measuring station, parallel blade precision controlled

volume dampers integral to the station and complete with actuator, and linkage shall be provided.

- d) Stations shall be installed in strict accordance with the manufacturer's published requirements, and in accordance with ASME Guidelines affecting non-standard approach conditions.

19) All air measuring devices shall be tested according to AMCA Standard 610.

20) Acceptable manufacturers: Johnson Controls, Air Monitor Corp., Tek-Air, Ruskin, and Dietrich Standard.

d. Static Pressure Traverse Probe

1) Duct static traverse probes shall be provided where required to monitor duct static pressure. The probe shall contain multiple static pressure sensors located along exterior surface of the cylindrical probe.

2) Acceptable manufacturers: Cleveland Controls

e. Shielded Static Air Probe

1) Where indicated on plans or in schedules a shielded static pressure probe shall be provided at each end of the building. The probe shall have multiple sensing ports, an impulse suppression chamber, and airflow shielding.

f. Water Flow Monitoring

1) Water flow meters shall be electromagnetic type with integral microprocessor-Based electronics. The meter shall have an accuracy of 0.25%.

2) Acceptable manufacturers: Onicon

G. Power Monitoring Devices

1. Current Measurement (amps)

a. Current measurement shall be by a combination current transformer and a current transducer. The current transformer shall be sized to reduce the full amperage of the monitored circuit to a maximum 5 Amp signal, which will be converted to a 4-20 mA DDC compatible signal for use by the Facility Management System.

b. Current Transformer – A split core current transformer shall be provided to monitor motor amps.

1) Operating frequency – 50 - 400 Hz

2) Insulation – 0.6 Kv class 10Kv BIL

3) UL recognized

4) Five amp secondary

5) Select current range as appropriate for application

6) Acceptable manufacturers: Setra

- c. Current Transducer – A current to voltage or current to mA transducer shall be provided. The current transducer shall include:
 - 1) 6X input over amp rating for AC inrushes of up to 120 amps
 - 2) Manufactured to UL 1244
 - 3) Accuracy: +.5%, Ripple +1%
 - 4) Minimum load resistance 30kOhm
 - 5) Input 0-20 amps
 - 6) Output 4-20 mA
 - 7) Transducer shall be powered by a 24 VDC regulated power supply (24 VDC +5%)
 - 8) Acceptable manufacturers: Setra

H. Smoke Detectors

- 1. Ionization type air duct detectors shall be furnished as specified elsewhere in Division 26 for installation under Division 23. All wiring for air duct detectors shall be provided under Division 26, Fire Alarm System.

I. Status and Safety Switches

1. General Requirements

- a. Switches shall be provided to monitor equipment status, safety conditions, and generate alarms at the Building Management System (DDC system) when a failure or abnormal condition occurs. Safety switches shall be provided with two sets of contacts and shall be interlock wired to shut down respective equipment.

2. Current Sensing Switches

- a. The current sensing switch shall be self-powered with solid-state circuitry and a dry contact output. It shall consist of a current transformer, a solid state current sensing circuit, adjustable trip point, solid state switch, SPDT relay, and an LED indicating the on or off status. A conductor of the load shall be passed through the window of the device. It shall accept over-current up to twice its trip point range.
- b. Current sensing switches shall be used for run status for fans, pumps, and other miscellaneous motor loads.
- c. Current sensing switches shall be calibrated to show a positive run status only when the motor is operating under load. A motor running with a broken belt or coupling shall indicate a negative run status.
- d. Acceptable manufacturers: Johnson Controls or approved equal

3. Air Filter Status Switches

- a. Differential pressure switches used to monitor air filter status shall be of the automatic reset type with SPDT contacts rated for 2 amps at 120VAC.
- b. A complete installation kit shall be provided, including: static pressure taps, tubing, fittings, and air filters.

- c. Provide appropriate scale range and differential adjustment for intended service.
 - d. Acceptable manufacturers: Johnson Controls, Cleveland Controls
 - 4. Air Flow Switches
 - a. Differential pressure flow switches shall be bellows actuated mercury switches or snap acting micro-switches with appropriate scale range and differential adjustment for intended service.
 - b. Acceptable manufacturers: Johnson Controls, Cleveland Controls
 - 5. Air Pressure Safety Switches
 - a. Air pressure safety switches shall be of the manual reset type with SPDT contacts rated for 2 amps at 120VAC.
 - b. Pressure range shall be adjustable with appropriate scale range and differential adjustment for intended service.
 - c. Acceptable manufacturers: Johnson Controls, Cleveland Controls
 - 6. Water Flow Switches
 - a. Water flow switches shall be equal to the Johnson Controls P74.
 - 7. Low Temperature Limit Switches
 - a. The low temperature limit switch shall be of the manual reset type with Double Pole/Single Throw snap acting contacts rated for 16 amps at 120VAC.
 - b. The sensing element shall be a minimum of 15 feet in length and shall react to the coldest 18-inch section. Element shall be mounted horizontally across duct in accordance with manufacturers recommended installation procedures.
 - c. For large duct areas where the sensing element does not provide full coverage of the air stream, additional switches shall be provided as required to provide full protection of the air stream.
 - d. The low temperature limit switch shall be equal to Johnson Controls A70.
- J. Control Relays
 - 1. Control Pilot Relays
 - a. Control pilot relays shall be of a modular plug-in design with retaining springs or clips.
 - b. Mounting Bases shall be snap-mount.

- c. DPDT, 3PDT, or 4PDT relays shall be provided, as appropriate for application.
 - d. Contacts shall be rated for 10 amps at 120VAC.
 - e. Relays shall have an integral indicator light and check button.
 - f. Acceptable manufacturers: Johnson Controls, Lectro
2. Lighting Control Relays
- a. Lighting control relays shall be latching with integral status contacts.
 - b. Contacts shall be rated for 20 amps at 277 VAC.
 - c. The coil shall be a split low-voltage coil that moves the line voltage contact armature to the On or Off latched position.
 - d. Lighting control relays shall be controlled by:
 - 1) Pulsed Tristate Output – Preferred method
 - 2) Pulsed Paired Binary Outputs
 - 3) A Binary Input to the Facility Management System shall monitor integral status contacts on the lighting control relay. Relay status contacts shall be of the “dry-contact” type.
 - e. The relay shall be designed so that power outages do not result in a change-of-state, and so that multiple same state commands will simply maintain the commanded state. Example: Multiple Off command pulses shall simply keep the contacts in the Off position.

K. Electronic Signal Isolation Transducers

- 1. A signal isolation transducer shall be provided whenever an analog output signal from the DDC system is to be connected to an external control system as an input (such as a chiller control panel), or is to receive as an input signal from a remote system.
- 2. The signal isolation transducer shall provide ground plane isolation between systems.
- 3. Signals shall provide optical isolation between systems.
- 4. Acceptable manufacturers: Advanced Control Technologies

L. Electronic/Pneumatic Transducers

- 1. Electronic to Pneumatic transducers shall provide:
 - a. Output: 3-15 psig
 - b. Input: 4-20 mA or 0-10 VDC
 - c. Manual output adjustment

- d. Pressure gauge
 - e. External replaceable supply air filter
2. Acceptable manufacturers: Johnson Controls, Mamac
- M. Thermostats – Electric
1. Electric room thermostats of the heavy-duty type shall be provided for unit heaters, cabinet unit heaters, and ventilation fans, where required. All these items shall be provided with concealed adjustment. Finish of covers for all room-type instruments shall match and, unless otherwise indicated or specified, covers shall be manufacturer's standard finish.
 2. Acceptable Manufacturers: Penn, Emerson, Honeywell

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for instruments installed in piping to verify actual locations of connections before installation.
- C. Examine roughing-in for instruments installed in duct systems to verify actual locations of connections before installation.
- D. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION, GENERAL

- A. Install products level, plumb, parallel, and perpendicular with building construction.
- B. Properly support instruments, tubing, piping, wiring, and conduit to comply with requirements indicated. Brace all products to prevent lateral movement and sway or a break in attachment when subjected to a force.
- C. Fastening Hardware:
 1. Stillson wrenches, pliers, and other tools that cause injury to or mar surfaces of rods, nuts, and other parts are prohibited for work of assembling and tightening nuts.
 2. Tighten bolts and nuts firmly and uniformly. Do not overstress threads by excessive force or by oversized wrenches.
 3. Lubricate threads of bolts, nuts, and screws with graphite and oil before assembly.

- D. Install products in locations that are accessible and that permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner's access, confirm unrestricted ladder placement is possible under occupied condition.

3.03 ELECTRIC POWER

- A. Furnish and install electrical power to products requiring electrical connections.
- B. Furnish and install circuit breakers. Comply with requirements in Section 26 28 16 "Enclosed Switches and Circuit Breakers."
- C. Furnish and install power wiring. Comply with requirements in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."
- D. Furnish and install raceways. Comply with requirements in Section 26 05 33 "Raceways and Boxes for Electrical Systems."

3.04 TEMPERATURE INSTRUMENT INSTALLATIONS

- A. Mounting Location:
 - 1. Roughing In:
 - a. Outline instrument mounting locations before setting instruments and routing cable, wiring, tubing, and conduit to final location.
 - b. Provide independent inspection to confirm that proposed mounting locations comply with requirements indicated and approved submittals.
 - 1) Indicate dimensioned locations with mounting height for all surface-mounted products on Shop Drawings.
 - 2) Do not begin installation without submittal approval of mounting location.
 - c. Complete installation rough-in only after confirmation by independent inspection is complete and approval of location is documented for review by Owner and Architect-Engineer on request.
 - 2. Install switches and transmitters for air and liquid temperature associated with individual air-handling units and associated connected ductwork and piping near air-handling units co-located in air-handling unit system control panel to provide service personnel a single and convenient location for inspection and service.
 - 3. Install liquid and steam temperature switches and transmitters for indoor applications in mechanical equipment rooms. Do not locate in user-occupied space unless indicated specifically on Drawings.
 - 4. Install air temperature switches and transmitters for indoor applications in mechanical equipment rooms. Do not locate in user-occupied space unless indicated specifically on Drawings.
 - 5. Mount switches and transmitters on walls, floor-supported freestanding pipe stands, or floor-supported structural support frames. Use manufacturer's mounting

brackets to accommodate field mounting. Securely support and brace products to prevent vibration and movement.

B. Special Mounting Requirements:

1. Protect products installed outdoors from solar radiation, building and wind effect with stand-offs and shields constructed of Type 316 stainless.
2. Temperature instruments having performance impacted by temperature of mounting substrate shall be isolated with an insulating barrier located between instrument and substrate to eliminate effect. Where instruments requiring insulation are located in finished space, conceal insulating barrier in a cover matching the instrument cover.

C. Mounting Height:

1. Mount temperature instruments in user-occupied space to match mounting height of light switches unless otherwise indicated on Drawings. Mounting height shall comply with codes and accessibility requirements.
2. Mount switches and transmitters located in mechanical equipment rooms and other similar space not subject to code or state and Federal accessibility requirements within a range of 42 to 72 inches above the adjacent floor, grade, or service catwalk or platform.
 - a. Make every effort to mount at 60 inches.

D. Seal penetrations to ductwork, plenums, and air-moving equipment to comply with duct static-pressure class and leakage and seal classes indicated using neoprene gaskets or grommets.

E. Space Temperature Sensor Installation:

1. Conceal assembly in an electrical box of sufficient size to house sensor and transmitter, if provided.
2. Install electrical box with a faceplate to match sensor cover if sensor cover does not completely cover electrical box.
3. In finished areas, recess electrical box within wall.
4. In unfinished areas, electrical box may be surface mounted if electrical light switches are surface mounted. Use a cast-aluminum electric box for surface-mounted installations.
5. Align electrical box with other electrical devices such as visual alarms and light switches located in the vicinity to provide a neat and well-thought-out arrangement. Where possible, align in both horizontal and vertical axis.

F. Outdoor Air Temperature Sensor Installation:

1. Mount sensor in a discrete location facing north.

2. Protect installed sensor from solar radiation and other influences that could impact performance.
3. If required to have a transmitter, mount transmitter remote from sensor in an accessible and serviceable location indoors.

G. Single-Point Duct Temperature Sensor Installation:

1. Install single-point-type, duct-mounted, supply- and return-air temperature sensors. Install sensors in ducts with sensitive portion of the element installed in center of duct cross section and located to sense near average temperature. Do not exceed 24 inches in sensor length.
2. Install return-air sensor in location that senses return-air temperature without influence from outdoor or mixed air.
3. Rigidly support sensor to duct and seal penetration airtight.
4. If required to have transmitter, mount transmitter remote from sensor at accessible and serviceable location.

H. Averaging Duct Temperature Sensor Installation:

1. Install averaging-type air temperature sensor for temperature sensors located within air-handling units, similar equipment, and large ducts with air tunnel cross-sectional area of 20 sq. ft. and larger.
2. Install sensor length to maintain coverage over entire cross-sectional area. Install multiple sensors where required to maintain the minimum coverage.
3. Fasten and support sensor with manufacturer-furnished clips to keep sensor taut throughout entire length.
4. If required to have transmitter, mount transmitter in an accessible and serviceable location.

I. Liquid Temperature Sensor Installation:

1. Assembly shall include sensor, thermowell and connection head.
2. For pipe NPS 4 and larger, install sensor and thermowell length to extend into pipe between 50 to 75 percent of pipe cross section.
3. For pipe smaller than NPS 4:
 - a. Install reducers to increase pipe size to NPS 4 at point of thermowell installation.
 - b. For pipe sizes NPS 2-1/2 and NPS 3, thermowell and sensor may be installed at pipe elbow or tee to achieve manufacturer-recommended immersion depth in lieu of increasing pipe size.
 - c. Minimum insertion depth shall be 2-1/2 inches.

4. Install matching thermowell.
5. Fill thermowell with heat-transfer fluid before inserting sensor.
6. Tip of spring-loaded sensors shall contact inside of thermowell.
7. For insulated piping, install thermowells with extension neck to extend beyond face of insulation.
8. Install thermowell in top dead center of horizontal pipe positioned in an accessible location to allow for inspection and replacement. If top dead center location is not possible due to field constraints, install thermowell at location along top half of pipe.
9. For applications with transmitters, mount transmitter remote from sensor in an accessible and serviceable location from floor.

3.05 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Each piece of wire, cable, and tubing shall have the same designation at each end for operators to determine continuity at points of connection. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."
- B. Install engraved phenolic nameplate with instrument identification.

3.06 CLEANING

- A. Remove grease, mastic, adhesives, dust, dirt, stains, fingerprints, labels, and other foreign materials from exposed interior and exterior surfaces.
- B. Wash and shine glazing.
- C. Polish glossy surfaces to a clean shine.

3.07 CHECK-OUT PROCEDURES

- A. Check installed products before continuity tests, leak tests, and calibration.
- B. Check temperature instruments for proper location and accessibility.
- C. Verify sensing element type and proper material.
- D. Verify location and length.
- E. Verify that wiring is correct and secure.

3.08 ADJUSTMENT, CALIBRATION, AND TESTING

- A. Description:
 1. Calibrate each instrument installed that is not factory calibrated and provided with calibration documentation.

2. Provide a written description of proposed field procedures and equipment for calibrating each type of instrument. Submit procedures before calibration and adjustment.
3. For each analog instrument, make a three-point test of calibration for both linearity and accuracy.
4. Equipment and procedures used for calibration shall meet instrument manufacturer's written instructions.
5. Provide diagnostic and test equipment for calibration and adjustment.
6. Field instruments and equipment used to test and calibrate installed instruments shall have accuracy at least twice the instrument accuracy being calibrated. For example, an installed instrument with an accuracy of 1 percent shall be checked by an instrument with an accuracy of 0.5 percent.
7. Calibrate each instrument according to instrument instruction manual supplied by manufacturer.
8. If after calibration indicated performance cannot be achieved, replace out-of-tolerance instruments.
9. Comply with field-testing requirements and procedures indicated by ASHRAE Guideline 11, "Field Testing of HVAC Control Components," in the absence of specific requirements and to supplement requirements indicated.

B. Analog Signals:

1. Check analog voltage signals using a precision voltage meter at zero, 50, and 100 percent.
2. Check analog current signals using a precision current meter at zero, 50, and 100 percent.
3. Check resistance signals for temperature sensors at zero, 50, and 100 percent of operating span using a precision-resistance source.

C. Digital Signals:

1. Check digital signals using a jumper wire.
2. Check digital signals using an ohmmeter to test for contact.

D. Sensors: Check sensors at zero, 50, and 100 percent of Project design values.

E. Switches: Calibrate switches to make or break contact at set points indicated.

F. Transmitters:

1. Check and calibrate transmitters at zero, 50, and 100 percent of Project design values.

2. Calibrate resistance temperature transmitters at zero, 50, and 100 percent of span using a precision-resistance source.

3.09 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.10 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain temperature instruments.
- B. Provide a complete set of instructional videos covering each product specified and installed and showing the following:
 1. Software programming.
 2. Calibration and test procedures.
 3. Operation and maintenance requirements and procedures.
 4. Troubleshooting procedures.
- C. Coordinate video with operation and maintenance manuals and classroom instruction for use by Owner in operating, maintaining, and troubleshooting.
- D. Record videos on DVD disks.
- E. Owner shall have right to make additional copies of video for internal use without paying royalties.

END OF SECTION 23 09 23.23

SECTION 23 09 23.33
CONTROL VALVES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00.
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) requirements.

1.03 SUMMARY

- A. Section includes control valves for DDC systems.
- B. Related Requirements:
 - 1. Section 23 09 23 “Direct-Digital Control System for HVAC” control equipment and software, relays, electrical power devices, uninterruptible power supply units, wire, and cable.

1.04 DEFINITIONS

- A. Cv: Design valve coefficient.
- B. DDC: Direct-digital control.
- C. NBR: Nitrile butadiene rubber.
- D. PTFE: Polytetrafluoroethylene

1.05 ACTION SUBMITTALS

- A. Product Data: For each type of product, including the following:
 - 1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes.
 - 2. Operating characteristics, electrical characteristics, and furnished accessories indicating process operating range, accuracy over range, control signal over range, default control signal with loss of power, calibration data specific to each unique application, electrical power requirements, and limitations of ambient operating environment, including temperature and humidity.
 - 3. Product description with complete technical data, performance curves, and product specification sheets.

4. Installation, operation, and maintenance instructions, including factors affecting performance.
- B. Shop Drawings:
1. Include plans, elevations, sections, and mounting details.
 2. Include details of product assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 3. Include diagrams for power, signal, and control wiring.
 4. Include diagrams for pneumatic signal and main air tubing.
- C. Delegated-Design Submittal:
1. Schedule and design calculations for control valves and actuators, including the following:
 - a. Flow at project design and minimum flow conditions.
 - b. Pressure differential drop across valve at project design flow condition.
 - c. Maximum system pressure differential drop (pump close-off pressure) across valve at project minimum flow condition.
 - d. Design and minimum control valve coefficient with corresponding valve position.
 - e. Maximum close-off pressure.
 - f. Leakage flow at maximum system pressure differential.
 - g. Torque required at worst case condition for sizing actuator.
 - h. Actuator selection indicating torque provided.

1.06 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. 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.
- B. ASME Compliance: Fabricate and label products to comply with ASME Boiler and Pressure Vessel Code where required by authorities having jurisdiction.
- C. Ground Fault: Products shall not fail due to ground fault condition when suitably grounded.

- D. Backup Power Source: Systems and equipment served by a backup power source shall have associated control valve actuators served from a backup power source.
- E. Determine control valve sizes and flow coefficients by ISA 75.01.01.
- F. Control valve characteristics and rangeability shall comply with ISA 75.11.01.
- G. Selection Criteria:
 - 1. Control valves shall be suitable for operation at following conditions:
 - a. Chilled Water: 150psi, 35°F - 140°F.
 - 2. Fail positions unless otherwise indicated:
 - a. Chilled Water: Open.
 - 3. Minimum Cv shall be calculated at 10 percent of design flow, with a coincident pressure differential equal to the system design pump head.
 - 4. In water systems, select modulating control valves at terminal equipment for a design Cv based on a pressure drop of 5 psig at design flow unless otherwise indicated.
 - 5. Modulating valve sizes for steam service shall provide a pressure drop at design flow equal to lesser of the following:
 - a. 50 percent of the valve inlet pressure.
 - b. 50 percent of the absolute steam pressure at the valve inlet.

2.02 CONTROL VALVES

- A. Ball Valves, 1/2 through 2 in.
 - 1. Ball Valves shall have forged brass bodies.
 - 2. Valves shall have available either Chrome Plated Brass Balls or 300 Series Stainless Steel Balls in all sizes.
 - 3. Valves shall have available either Nickel Plated Brass Stems or 300 Series Stainless Steel Stems with a blow-out proof stem design in all sizes.
 - 4. Valves shall have Graphite reinforced Polytetrafluoroethylene (PTFE) seats with Ethylene Propylene Diene Monomer (EPDM) O-ring backing.
 - 5. Stem seals shall be double EPDM O-rings.
 - 6. Flow Characterization Disk shall be manufactured from Amodel AS-1145HS Polyphthalamide Resin and rated for 50 psi maximum differential pressure and shall be inserted against the casting of the valve.
 - 7. All ball valves with internal pipe thread end connections shall be rated to 580 psi maximum static pressure at 203°F (95°C) fluid temperature.

8. All ball valves with sweat end connections or press end connection shall be rated to 300 psig maximum static pressure at 203°F (95°C) fluid temperature.
9. All valves shall be rated for service with hot water, chilled water and 50% glycol solutions.
10. Ball Valves with stainless steel balls and stems shall be rated for use with 15 psig saturated steam.
11. Flow Characteristics shall be equal percentage on the control port. Bypass port on three-way valves shall have linear flow characteristics.
12. Valves shall have a maximum leakage specification of 0.01% of maximum flow for the control port, ANSI/FCI 70-2, Class 4 and 1% of maximum flow, bypass port.
13. Valves shall be maintenance free.
14. Valves shall be provided with a 5 year equipment warranty.
15. Valves shall be rated for 200 psi differential closeoff pressure.
16. Valve actuators shall be UL-recognized or CSA-certified.
17. Valves shall be Johnson Controls VG1000 Series ball valves or approved equal.

B. Ball Valves, ½ in. to 1 in. with integrated Controller

1. Ball valves shall have forged brass bodies.
2. Valves shall be available in either chrome plated brass balls or 300 series stainless steel balls in all sizes. Note that the FX-PCV is currently only available with brass trim.
3. Valves shall be available in all sizes with either a nickel plated brass stems or 300 series steel stems with a blow-out proof stem design. Note that the FX-PCV is currently only available with brass trim.
4. Valves shall have graphite reinforced PTFE seats with EPDM O-ring backing.
5. Stem seals shall be double EPDM O-rings.
6. Flow characterization disks shall be manufactured from Amodel AS-1145HS Polyphthalamide Resin and rated for 50 psid maximum differential pressure and shall be inserted against the casting of the valve. The valves shall be installed in any flow direction because of the non-directional disk design.
7. Flow characteristics shall be of equal percentage on the control port. Bypass port on three-way valves shall have linear flow characteristics.
8. Valves with internal pipe thread end connections shall be rated to 580 psi maximum static pressure at 203°F (95°C) fluid temperature.

9. Valves with sweat end connections or press end connection shall be rated to 300 psig (kPa) maximum static pressure at 203°F (95°C) fluid temperature.
10. Valves shall be rated for service with hot water, chilled water and 50% glycol solutions.
11. Ball valves with stainless steel balls and stems shall be rated for use with 15 psig (103 kPa) saturated steam. Note that the FX-PCV cannot be used for steam applications.
12. Ball valves shall have a maximum leakage specification of 0.01% of maximum flow for the control port, ANSI/FCI 70–2, Class 4 and 1% maximum flow, bypass port.
13. Ball valves shall be maintenance free.
14. Ball valves shall be provided with a 5 year warranty from the date of sale. Valves sold in the APAC region shall comply with an 18 month warranty policy.
15. Ball valves shall be rated for 200 psid (1,378 kPa) close off pressure.
16. Ball valves shall be UL–recognized or CSA-certified. APAC valves shall be excluded from this regulatory information.
17. Ball valves shall be Johnson Controls VG1000 Series Ball Valves or approved equal.

C. Ball valves ½ in. through 1 in with integrated Controllers and actuators

1. The specifications apply to Ball valves ½ in. through 1 in. with integrated Controller or actuators.
2. The actuator or Controller shall provide both standalone and networked direct digital control of terminal units.
3. The actuator or Controller shall be BACnet Testing Labs (BTL) listed/certified and carry the BTL Label.
4. The actuator or Controller shall tested and certified as a BACnet Application Specific Controller (B-ASC).
5. A BACnet Protocol Implementation Conformance Statement shall be provided for the actuator or Controller.
6. The actuator or Controller shall communicates over the Field Controller Bus (FC Bus) using BACnet Standard protocol SSPC-135, Clause 9.
7. The actuator or Controllers shall have internal electrical isolation for AC power, DC inputs, and MS/TP communications. An externally mounted isolation transformer shall not be acceptable.
8. The actuator/Controller shall be a configurable digital Controller. All components shall be connected and mounted as a single assembly that can be removed as one

piece. With ball valve linkage for use on the Johnson Controls VG-1000 1/2 inch to 1 inch valves.

9. The actuator or Controller shall be assembled in a plenum-rated plastic housing with flammability rated to UL95-5VB or the Controller is designed and suitable for use in other environmental air spaced (plenums) in accordance with Section 300.252© of the National Electrical Code.
10. Each Controller shall continuously and adaptively tune the control algorithms to improve control and Controller reliability through reduced actuator duty cycle. This shall reduce commissioning costs and eliminated the maintenance costs of manually re-tuning loops to compensate for load changes.
11. The Controller shall provide the ability to download and upload configuration files, both locally and through the communications network. Controllers shall be able to be loaded individually or as a group using a zone schedule generated spreadsheet of Controller parameters.
12. Control set point changes initiated over the network shall be written to the actuator or the Controller's non-volatile memory to prevent the loss of set point changes and to prove consistent operation in the event of a communication failure.
13. The Controller firmware shall be flash-upgradeable remotely through the communications bus to minimize the cost of feature enhancements.
14. Inputs:
 - a. Analog inputs with user defined ranges shall monitor the following analog signals, with only the equipment in the terminal Controller cabinet:
 - 1) 0 VDC to 10 VDC Sensors
 - 2) 1000 ohm RTDs
 - 3) NTC Thermistors
 - b. Binary inputs shall monitor dry contact closures. Filtering shall eliminate false signals resulting from input 'bouncing'.
 - c. The inputs shall be isolated from power, communications, and output circuits for noise immunity.
 - d. Provide side loop application for humidity control.
15. Outputs:
 - a. Analog output shall provide a 0 VDC to 10 VDC control output.
 - b. Binary outputs shall provide a SPST Triac output rated for 500 mA at 24 VAC.
 - c. For noise immunity, the outputs shall be internally isolated from power, communications, and other output circuits.
16. The actuator or Controller shall be configured with a software tool that provides a question and answer format for developing and downloading applications.

17. Sensor support:
 - a. The actuator or Controller shall communicate over the Sensor-Actuator Bus (SA Bus) with a Network Sensor.
 - b. The actuator or Controller shall support an LCD display room sensor.
 - c. The actuator or Controllers shall support standard room sensors as defined by analog input requirements.
 - d. The actuator or Controllers shall support humidity sensors defined by the AI side loop.

D. Ball Valves, 2 in. to ½ in through 4 in. Flanged

1. Ball valves shall have forged brass bodies with ASME Class 150 ductile iron flanges.
2. Valves shall be manufactured from 300 series stainless steel balls and the flanges shall rotate independently until tightened down which is an advantage during installation.
3. Valves shall have 300 series steel stems with a blow-out proof stem design.
4. Stem seals shall have double EPDM O-rings.
5. Valves have graphite reinforced PTFE seats with EPDM O-ring backing.
6. Flow characterization disk shall be manufactured from Amodel AS-1145HS Polyphthalamide Resin and rated for 50 psid maximum differential pressure.
7. Flow characteristics shall be of equal percentage on the control port. Bypass port on three-way valves shall have linear flow characteristics.
8. Valves shall be rated for service with hot water, chilled water and 50% glycol solutions and are rated for use with 25 psig (kPa) saturated steam.
9. Two-way valves shall be rated for 100 psid close off pressure and three-way valves shall be rated for maximum of 50 psid close off pressure.
10. Valves shall have a maximum leakage specification of 0.01% of maximum flow for the control port, ANSI/FCI 70-2, Class 4 and 1% of maximum flow, bypass port.
11. Valves shall be maintenance free.
12. Valves shall be provided with a 5 year warranty. Valves sold in the APAC region shall comply with an 18 month warranty policy.
13. Valves shall be CE marked as Johnson Controls declares these valves are in compliance with essential requirements and other relevant provisions of the Pressure Equipment Directive (PED). APAC actuators shall be excluded from this regulatory information.

14. Valves shall be Johnson Controls VG1000 Series ball valves or approved equal.
- E. Six-Way Control Ball Valves, ½ in. and ¾ in.
1. Six-way valves shall have forged brass bodies which comply with PN16 (300 psi) static pressure rating.
 2. Valves shall have chrome plated brass balls.
 3. Valves shall have nickel plated brass stems which include a blow-out proof stem.
 4. Valves shall have graphite reinforced PTFE seats with EPDM O-ring backing.
 5. Stem seals shall be double EPDM O-rings. All seals shall combine to provide a completely leak-free sealing system. The packing shall be laboratory tested and proven leak-free after 100,000 cycles in iron-oxide contaminated water test of a minimum 900ppm.
 6. Valves shall be available in female NPT, sweat connection and British Standard Pipe Parallel (BSPP).
 7. Valves shall be capable of 3.8Cv (3.3Kv) for ½ in. series and 7.4Cv (6.3Kv) for ¾ in. series.
 8. Flow characterization disks shall be manufactured from Amodel AS-1145HS Polyphthalamide Resin and rated for 50 psid maximum differential pressure and shall be inserted against the casting of the six-way valve.
 9. Flow characteristics shall be of equal percentage on the control port. Bypass port on three-way six-way valves shall have linear flow characteristics.
 10. All ball valves with internal pipe thread end connections shall be rated to 580 psi maximum static pressure at 230°F (95°C) fluid temperature.
 11. Six-way valves with sweat end connections or press end connection shall be rated to 300 psig (kPa) maximum static pressure at 203°F (95°F) fluid temperature.
 12. All six-way valves shall be rated for service with hot water, chilled water and 50% glycol solutions. Six-way valves shall be field supplied with Cv (Kv) control flow disks. This provides the right flow rate for a wide range of applications.
 13. Six-way valve bodies shall be designed to regulate media flow which utilizes 270° of rotation with a true close-off feature. It is internal to the valve and isolates source 1 of the circuit from source 2 of the circuit. This shall provide the most efficient way of transition between both hot and chilled water in response to the demand of a Controller in HVAC systems.
 14. Valves shall be rated for 50 psid close off pressure.
 15. Six-way valves shall have a maximum leakage specification of 0.01% of maximum flow for the control port, ANSI/FCI 70-2, Class 4 and 1% of maximum flow, bypass port.
 16. Six-way valves shall be maintenance free.

17. Six-way valves shall be provided with a 5 year warranty. Valves sold in the APAC region shall comply with an 18 month warranty policy.
 18. Valves shall be Johnson Controls VG1600 Series ball valves or approved equal.
- F. Six-Way Valves with 270° rotary proportional Non-Spring Return Actuator VA9905-KGA-2
1. The coupling between the valve and actuator shall be designed as a convenient mounting system in order to ensure quick installation reducing the risk of installation errors.
 2. The actuator shall be configured for multi-input control using either 0V to 10V or 2V to 10V or 0(4)mA to 20mA with field furnished 500 ohm ¼ W resistor and shall be configurable, programmed or work with conventional equipment Controllers and thermostats. This is important for improved control and precision.
 3. Dual voltage control, thermostat control, and single analog control.
 4. The actuator shall utilize a microprocessor-Controller brushless DC motor which provides constant runtime independent of torque and increases the lifecycle by reducing water.
 5. The actuator shall not produce audible noise greater than 35 dBA at 1 m (39 to 13/32 in.).
 6. The actuator shall utilize mode configuration switch which permits calibration of input signal range selection.
 7. Installation and wiring shall be simplified by the integral cables with colored and numbered conductors.
 8. The 270° six-way control valve shall be furnished with an internal pressure relief system which is designed to prevent any damage in the terminal unit circuit. The valve and actuator shall work as follows:
 - a. When the valve is in close position, for both cooling and heating operating modes, the trapped fluid may vary its pressure due to changes in ambient temperature.
 - b. The pressure compensation system relieves such pressure changes.
 - c. The actuator has the capability to be wired directly to a building management Controller by analog wiring or directly wired to a 24 VAC thermostat.
 - d. In order to connect the terminal unit circuit with either the sequence 1 or 2 circuit (expansion vessel), the design of the upper valve means there is no gasket required, while the lower valve provides a true close off.
 - e. When the valve is in closed position the water flows inside the upper ball, entering the inlet of the terminal unit because there is no gasket for prevention.
 9. The actuator shall utilize mode configuration switch which can permit calibration of input signal range selection.

10. The actuator shall have the option of an integral ½ in. (13mm) threaded conduit connector's option for improved installation and field wiring.
11. The actuator shall include a position indicator handle and manual override which allows intuitive indication of valve position and manual shut off.
12. The actuator shall have a small footprint making application in smaller spaces easier.
13. The actuator shall pass laboratory test of 100,000 cycles and 2.5 million repositions to ensure reliability over time.
14. The valves shall carry a 5 year warranty. Valves sold in the APAC region shall comply with an 18 month warranty policy.
15. The actuator shall be NEMA/IP54 Enclosure standards which enhances the range of application environments.
16. The NSR Actuators shall be offered in a plenum-rated model which enables use in other environmental air spaces(plenums) in accordance with 300.22 © of the National Electric Code.
17. The valves and actuator shall comply with the Underwriters Laboratories Inc. © (UL), CE Mark, and RCM Compliance which provide internationally recognized regulatory agency approvals. APAC actuators and valves shall be excluded from this regulatory information.
18. The actuator shall be manufactured under International Standards Organization (ISO) 9001 Quality Control Standards to ensure quality.
19. The actuators shall be Johnson Controls 9905 actuators or approved equal.

G. Butterfly Valves, 2 through 20 in. resilient seat ASME Class 125/150 Flanged

1. Butterfly valves shall have cast iron bodies meeting ASTM A126 Class B requirements, meet ASME class 125/150 flange requirements and shall be fully lugged.
2. Valves seats shall be EPDM.
3. Valves disks shall be ductile iron with Nylon 11 coating.
4. Valves stems shall be stainless steel.
5. Flow characteristics shall be of equal percentage up to 70 degrees of disk rotation.
6. Valves shall be rated for service with hot water, chilled water and 50% glycol solutions.
7. Valves shall be maintenance free.
8. Valves shall be provided with a 3 year warranty. Valves sold in the APAC region shall comply with an 18 month warranty policy.

9. Valves shall be UL-recognized and CSA-certified. Valves sold in the APAC region shall be excluded from this regulatory information.
 10. Valves shall be Johnson Controls VF series butterfly valves or approved equal.
- H. Butterfly Valves, High Performance 2-1/2 through 16 in.
1. Butterfly valve shall have bodies manufactured from carbon steel, ASTM A216 GR WCB/A516 GR 70 and shall be fully lugged per ASME Class 150 or ASME Class 300.
 2. Valve seat assemblies shall be RPTFE (reinforced polytetrafluorethylene) and the seat retainer shall be carbon steel, ASTM A516 GR 70.
 3. Valve disks shall be stainless steel, ASTM A 351 GR CF8M.
 4. Valve stems shall be 17-4 PH stainless steel, ASTM A564-Type 630.
 5. Stem seals shall be one carbon fiber ring and three TFE rings.
 6. Flow characteristics shall be equal percentage up to 70° of disk rotation.
 7. Valves shall be rated for service with hot water, chilled water, 50% glycol solutions and 50 psig (kPa) saturated steam in modulating service or 150 psig (kPa) saturated steam in two position service.
 8. Valves shall meet the performance requirements of the ASMA Class 150 and Class 300.
 9. Valves shall be maintenance free.
 10. Valves shall be provided with a 3 year warranty. Valves sold in the APAC region shall comply with an 18 month warranty policy.
 11. Valves shall be UL-recognized or CSA-certified. APAC valves shall be excluded from this regulatory information.
 12. Valves shall be Johnson Controls VF Series Butterfly Valves or approved equal.
- I. Globe Valves, Brass, 1/2 through 2 in.
1. Globe valve stems shall be manufactured from 300 series stainless steel.
 2. Valves with brass plugs and seats shall have stem seals with self-adjusting Ethylene Propylene Rubber (EPR) Ring Pack U-Cups.
 3. Valves with stainless steel plugs and seats shall have valve stem seals with spring loaded PTFE and Elastomer V-Rings.
 4. Flow characteristics shall be of equal percentage for two-way valves and linear for three-way valves.
 5. Valves shall meet the pressure and temperature requirements of ANSI B16.15, Class 250.

6. Valves with brass trim shall have a maximum leakage specification of 0.01% of maximum flow per ANSI/FCI 70-2, Class 4.
 7. Valves with stainless steel trims shall have a maximum leakage of 0.05% of maximum flow.
 8. Valves shall be serviceable without being removed from the pipe.
 9. Valves shall be provided with a 3 year warranty. Valves sold in the APAC region shall comply with an 18 month warranty policy.
 10. Valve bodies shall be manufactured from a RoHS compliant brass.
 11. Valves electric actuators shall be UL-recognized or CSA-certified. APAC valves shall be excluded from this regulatory information.
 12. Globe valves shall be Johnson Controls VG7000 Series Globe Valves or an approved equal.
- J. Globe Valves, Cast Iron, 2-1/2 through 6 in.
1. Globe valve bodies shall be manufactured from cast iron.
 2. Valve stems shall be manufactured from 316 series stainless steel.
 3. Valves shall have stem seals with Ethylene Propylene Terpolymer (EPT) Ring Pack U-Cups.
 4. Flow characteristics shall be equal modified linear.
 5. Valves shall meet the pressure and temperature requirements of ANSI B16.15, Class 125.
 6. Valves shall have a maximum leakage specification of 0.01% of maximum flow per ANSI/FCI 70-2, Class 3.
 7. Valves shall be serviceable without being removed from the pipe.
 8. Valves shall be provided with a 3 year warranty. Valves sold in the APAC region shall comply with an 18 month warranty policy.
 9. Valve electric actuators shall be UL-recognized or CSA-certified. APAC valves shall be excluded from this regulatory information.
- K. Valves Electric Zone Valves, 1/2 through 1-1/4 in.
1. Electric zone valves shall have bodies manufactured from forged brass.
 2. Valve stems shall be manufactured from hard chrome plated brass.
 3. Modulating valves flow characteristics shall be of equal percentage.
 4. Valves shall be rated for service with hot water, chilled water and 50% glycol solutions.

5. Two position valves shall have models available rated for use with 15 psig saturated steam.
6. Valves shall be replaceable without being removed from the pipe.
7. Valves are provided with a 2 year warranty. Valves sold in the APAC region comply shall with an 18 month warranty policy.
8. Valves shall be UL, cUL listed or CSA certified. APAC valves shall be excluded from this regulatory information.
9. Valves shall be Johnson Controls J Series electric zone valves or an approved equal.

2.03 PRESSURE-INDEPENDENT VALVES

A. Pressure-Independent Ball Valves NPS 2 in. (DN 50) and smaller

1. Pressure-Independent Ball Valves shall have bodies manufactured from Dezincification resistant (DZR) forged brass, or cast iron.
2. Valves balls shall be manufactured from chrome plated-brass.
3. Valve ball seats shall be manufactured from PTFE.
4. Valves stem seal shall be PTFE packing ring stem seals with EPDM.
5. Valves stem and stem extensions shall be manufactured from brass with a blowout-proof design.
6. Pressure-independent ball valves shall have a pressure rating of 360 psig (2482 kPa) for NPS 1/2 to 1-1/4 (DN 15 to 32) and 230 psig (1585 kPa) for NPS 1-1/2 to NPS 2 (DN 38 to DN 50).
7. Valves shall have a close-off pressure of 200 psig (1379 kPa).
8. Valves shall have a fluid temperature limit of 14°F to 248 °F (-10°C to 120 °C), Not Rated for Steam Service.
9. The maximum actuator fluid temperature limit shall be 14°F to 212°F (-10°C to 100°C) which is not the rate for steam service.
10. Valves shall have an accuracy of +/-5% up to 15psid.
11. Valves flow characteristics shall be of equal percentage with a characterized profile laser cut which is directly into the ball.
12. Valves shall have a maximum leakage in accordance with the ANSI Class IV IEC 60534-4, Class IV Leakage.
13. Valves shall have an integral pressure regulator to regulate pressure, to maintain a constant pressure differential while operating within a pressure differential range of 5 psig to 58 psig (34 kPa to 400 kPa).

14. Valves shall have a pressure regulator which is removable and replaceable from the valve body NPS ½ .in to 1 .in to 1/4 .in (DN 15 to DN 32).
15. Valves shall have a threaded NPT connections.
16. Two pressure testing (P/T) ports shall be incorporated into the valve body for differential pressure verification.
17. Valves and actuators shall be supplied as an assembly.
18. Valves and actuators shall be provided with a 5 year warranty. Valves sold in the APAC region shall comply with an 18 month warranty policy.
19. Pressure-Independent Ball Valves shall be Johnson Controls VP140 Series pressure independent valves or an approved equal.

B. Pressure-Independent Globe Valves NPS ½ in. to ¾ .in (DN 15-20)

1. Pressure-Independent Globe Valves bodies shall be manufactured from DZR forged brass.
2. Valves shall have a pressure rating of 360 psig (2482 kPa).
3. Valves shall have a close-off pressure of 100 psig (700 kPa).
4. Valves fluid temperature limit shall be 14°F to 248°F (-10°C to 120°C) which is not rated for steam service.
5. Valves accuracy shall be +/-5% up to 15 psid.
6. Valves flow characteristic shall be inherently linear and capable of equi-percentage with actuator.
7. Valves shall have a maximum leakage in accordance with ANSI Class IV IEC 60534-4, Class IV Leakage.
8. Valves shall have an integral pressure regulator to regulate pressure to maintain a constant pressure differential while operating within a pressure differential range of 5 psig to 87 psig (34 kPa to 600 kPa). Pressure regulator shall be serviceable/replaceable without special tools.
9. Valves dirt free design shall allow the valve to pass strife contaminated water tests of 100,000 cycles at 900ppm iron oxide.
10. Valves shall have a threaded NPT connections.
11. Two P/T ports shall be incorporated into the valve body for differential pressure verification.
12. Valves pre-set function shall be adjustable for max flow without special tools.
13. Valves and actuators shall be supplied as an assembly, the single actuator shall be capable of:

- a. Auto calibration
 - b. Linear and equi-percentage control curve
 - c. VDC or mA control signal, with selection of control signal to be either 0 VDC to 10 VDC, 2 VDC to 10 VDC, 0 VDC to 5 VDC, 5 VDC to 10 VDC, 0 mA to 20 mA, 4 mA to 20 mA
 - d. LED feedback indication to indicate moving to position, end of stroke confirmation position reached, cycling and loss of signal
14. Pressure-independent globe valves and actuators shall be provided with a 5 year warranty.
15. All valves shall be Johnson Controls VP140 Series pressure independent valves or an approved equal.
- C. Pressure-Independent Ball Valves NPS ½ in. through 1 in. to 1/4 in with integrated Controller
- 1. Pressure-Independent Ball Valves shall have bodies manufactured from DZR forged brass, or cast iron.
 - 2. Valve Balls shall be chrome-plated brass.
 - 3. Valve stems and stem extensions shall be brass, blowout-proof design.
 - 4. Valve ball seats shall be PTFE.
 - 5. Valves stem seal shall be PTFE packing ring stem seals with EPDM.
 - 6. Valves shall have a threaded NPT connections.
 - 7. Valves shall have a pressure rating of 360 psig (2482 kPa) for NPS ½ in. through 1 in. to ¼ in. (DN 15 to 32).
 - 8. Valves close off pressure shall be 200 psig (1370 kPa).
 - 9. Valves fluid temperature limits shall be 14°F to 248°F (-10°C to 120°C) which is not rated for steam service.
 - 10. Valves maximum actuator fluid temperature limits shall be 14°F to 212°F (-10°C to 100°C) which is not rated for steam service.
 - 11. Valves accuracy shall be +/- 5% up to 15 psid.
 - 12. Valves flow characteristic shall be of equal percentage with characterized profile laser cut directly into the ball.
 - 13. Valves maximum leakage shall be in accordance with the ANSI Class IV IEC 60534-4, American National Standards Institute (ANSI) Class IV Leakage.

14. Valves Integral pressure regulator shall be designed to regulate pressure and to maintain a constant pressure differential while operating within a pressure differential range of 5 psig to 58 psig (34 kPa to 400 kPa).
 15. Valves pressure regulators shall be removable or replaceable from the valve body from NPS ½ in. through 1 in. to ¼ in. (DN 15 to DN 32).
 16. Two P/T ports shall be incorporated into the valve bodies for differential pressure verification.
 17. Valves and actuators shall be provided with a 5 year warranty. Valves sold in the APAC region shall comply with an 18 month warranty policy.
 18. All valves shall be Johnson Controls VP140 Series pressure independent valves or an approved equal.
- D. Pressure-Independent Ball Valves NPS ½ in. through 1 in. to ¼ in. with integrated Controller
1. The specifications apply to Pressure-Independent Ball valves ½ in. through 1 in. to
 2. ¼ in. with integrated Controller or actuators.
 3. The actuator or Controller shall provide both standalone and networked direct digital control of terminal units.
 4. The actuator or Controller shall be BACnet Testing Labs (BTL) listed/certified and carry the BTL Label.
 5. The actuator or Controller shall be tested and certified as a BACnet Application Specific Controller (B-ASC).
 6. A BACnet Protocol Implementation Conformance Statement shall be provided for the actuator or Controller.
 7. The actuator or Controller shall communicate over the Field Controller Bus (FC Bus) using BACnet Standard protocol SSPC-135, Clause 9.
 8. The actuator or Controllers shall have internal electrical isolation for AC power, DC inputs, and MS/TP communications. An externally mounted isolation transformer shall not be acceptable.
 9. The actuator or Controller shall be a configurable digital Controller. Connecting and mounting all the components as a single assembly, enabling the component to be removed as one piece. With ball valve linkage for use on the Johnson Control VP140 ½ in. through 1.in to ¼ in. valves.
 10. The actuator or Controller shall be assembled in a plenum-rated plastic housing with flammability rated to UL95-5VB or the Controller is designed and suitable for use in other environmental air spaced (plenums) in accordance with Section 300.252© of the National Electrical Code.

11. All Controllers shall continuously and adaptively tune the control algorithms to improve control and Controller reliability through reduced actuator duty cycle. This shall reduce commissioning costs and eliminated the maintenance costs of manually re-tuning loops to compensate for load changes.
12. The Controller shall provide the ability to download and upload configuration files, both locally and through the communications network. Controllers shall be able to be loaded individually or as a group using a zone schedule generated spreadsheet of Controller parameters.
13. Control set point changes initiated over the network shall be written to the actuator or the Controller's non-volatile memory to prevent the loss of set point changes and to prove consistent operation in the event of a communication failure.
14. The Controller firmware shall be flash-upgradeable remotely through the communications bus to minimize the cost of feature enhancements.
15. Inputs:
 - a. Analog inputs with user defined ranges shall monitor the following analog signals, with only the equipment in the terminal Controller cabinet:
 - 1) 0 VDC to 10 VDC Sensors
 - 2) 1000 ohm RTDs
 - 3) NTC Thermistors
 - b. Binary inputs shall monitor dry contact closures. Filtering eliminates false signals resulting from input 'bouncing'.
 - c. The inputs shall be isolated from power, communications, and output circuits for noise immunity.
 - d. Humidity control shall be provided by side loop applications.
16. Outputs:
 - a. Analog output shall provide a 0 VDC to 10 VDC control output.
 - b. Binary outputs shall provide a SPST Triac output rated for 500 mA at 24 VAC.
 - c. The inputs shall be isolated from power, communications, and output circuits for noise immunity.
17. The actuator or Controller shall be configured with a software tool which provides a question and answers format for developing and downloading applications.
18. Sensor support:
 - a. The actuator or Controller shall communicate over the Sensor-Actuator Bus (SA Bus) with a Network Sensor.
 - b. The actuator or Controllers shall support an LCD display room sensor.

- c. The actuator or Controllers shall support standard room sensors as defined by analog input requirements.
 - d. The actuator or Controllers shall support humidity sensors defined by the AI side loop.
- E. Piping packages
- 1. Piping packages shall be supplied with control valve and actuator assembly packs.
 - 2. Piping packages assemblies shall be factory leak tested at 100 psi for 24 hours.
 - 3. Piping packages shall include pressure gages.
 - 4. Piping packages shall be pressurized at 40 psi with pressure gages reflecting internal pressure of assembly.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for valves installed in piping to verify actual locations of piping connections before installation.
- C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 CONTROL VALVE APPLICATIONS

- A. Control Valves:
 - 1. Select from valves specified in “Control Valves” Article to achieve performance requirements and characteristics indicated while subjected to full range of system operation encountered.
 - 2. Chilled Water System, Three-Way Applications Controlled by Flow: Ball valves with single port and characterized disk.
 - 3. Chilled Water System, Two-Way Applications Controlled by Temperature: Ball valves with two ports and characterized disk.

3.03 INSTALLATION, GENERAL

- A. Furnish and install products required to satisfy most stringent requirements indicated.
- B. Install products level, plumb, parallel, and perpendicular with building construction.
- C. Properly support instruments, tubing, piping, wiring, and conduits to comply with requirements indicated. Brace all products to prevent lateral movement and sway or a break in attachment when subjected to a force.

- D. Provide ceiling, floor, roof, and wall openings and sleeves required by installation. Before proceeding with drilling, punching, or cutting, check location first for concealed products that could potentially be damaged. Patch, flash, grout, seal, and refinish openings to match adjacent condition.
- E. Firestop penetrations made in fire-rated assemblies and seal penetrations made in acoustically rated assemblies.
- F. Fastening Hardware:
 - 1. Stillson wrenches, pliers, and other tools that will cause injury to or mar surfaces of rods, nuts, and other parts are prohibited for assembling and tightening nuts.
 - 2. Tighten bolts and nuts firmly and uniformly. Do not overstress threads by excessive force or by oversized wrenches.
 - 3. Lubricate threads of bolts, nuts, and screws with graphite and oil before assembly.
- G. Install products in locations that are accessible and that will permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner's access, confirm unrestricted ladder placement is possible under occupied condition.
- H. Corrosive Environments:
 - 1. Use products that are suitable for environment to which they will be subjected.
 - 2. If possible, avoid or limit use of materials in corrosive environments, including, but not limited to, the following:
 - a. Laboratory exhaust airstreams.
 - b. Process exhaust airstreams.
 - 3. Use Type 316 stainless-steel tubing and fittings when in contact with a corrosive environment.
 - 4. When conduit is in contact with a corrosive environment, use Type 316 stainless-steel conduit and fittings or conduit and fittings that are coated with a corrosive-resistant coating that is suitable for environment.
 - 5. Where control devices are located in a corrosive environment and are not corrosive resistant from manufacturer, field install products in a NEMA 250, Type 4X enclosure constructed of Type 316L stainless steel.

3.04 ELECTRIC POWER

- A. Furnish and install electrical power to products requiring electrical connections.
- B. Furnish and install circuit breakers. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers."
- C. Furnish and install power wiring. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

- D. Furnish and install raceways. Comply with requirements in Section 260533 “Raceways and Boxes for Electrical Systems.”

3.05 CONTROL VALVES

- A. Install pipe reducers for valves smaller than line size. Position reducers as close to valve as possible but at distance to avoid interference and impact to performance. Install with manufacturer-recommended clearance.
- B. Install flanges or unions to allow drop-in and -out valve installation.
- C. Where indicated, install control valve with three-valve bypass manifold to allow for control valve isolation and removal without interrupting system flow by providing manual throttling valve in bypass pipe.
- D. Install drain valves in piping upstream and downstream of each control valve installed in a three-valve manifold and for each control valve larger than NPS 2.
- E. Install pressure temperature taps in piping upstream and downstream of each control valve larger than NPS 1.
- F. Valve Orientation:
 - 1. Where possible, install globe and ball valves installed in horizontal piping with stems upright and not more than 15 degrees off of vertical, not inverted.
 - 2. Install valves in a position to allow full stem movement.
 - 3. Where possible, install butterfly valves that are installed in horizontal piping with stems in horizontal position and with low point of disc opening with direction of flow.
- G. Clearance:
 - 1. Locate valves for easy access and provide separate support of valves that cannot be handled by service personnel without hoisting mechanism.
 - 2. Install valves with at least 12 inches of clear space around valve and between valves and adjacent surfaces.
- H. Threaded Valves:
 - 1. Note internal length of threads in valve ends, and proximity of valve internal seat or wall, to determine how far pipe should be threaded into valve.
 - 2. Align threads at point of assembly.
 - 3. Apply thread compound to external pipe threads, except where dry seal threading is specified.
 - 4. Assemble joint, wrench tight. Apply wrench on valve end as pipe is being threaded.
- I. Flanged Valves:

1. Align flange surfaces parallel.
2. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly with a torque wrench.

3.06 CONNECTIONS

- A. Connect electrical devices and components to electrical grounding system. Comply with requirements in Section 260526 “Grounding and Bonding for Electrical Systems.”

3.07 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Each piece of wire, cable, and tubing shall have the same designation at each end for operators to determine continuity at points of connection. Comply with requirements for identification specified in Section 260553 “Identification for Electrical Systems.”
- B. Install engraved phenolic nameplate with valve identification on valve and on face of ceiling directly below valves concealed above ceilings.

3.08 CLEANING

- A. Remove grease, mastic, adhesives, dust, dirt, stains, fingerprints, labels, and other foreign materials from exposed interior and exterior surfaces.
- B. Wash and shine glazing.
- C. Polish glossy surfaces to a clean shine.

3.09 CHECKOUT PROCEDURES

- A. Control Valve Checkout:
 1. Check installed products before continuity tests, leak tests, and calibration.
 2. Check valves for proper location and accessibility.
 3. Check valves for proper installation for direction of flow, elevation, orientation, insertion depth, or other applicable considerations that will impact performance.
 4. For pneumatic products, verify air supply for each product is properly installed.
 5. For pneumatic valves, verify that pressure gauges are provided in each air line to valve actuator and positioner.
 6. Verify that control valves are installed correctly for flow direction.
 7. Verify that valve body attachment is properly secured and sealed.
 8. Verify that valve actuator and linkage attachment are secure.
 9. Verify that actuator wiring is complete, enclosed, and connected to correct power source.

10. Verify that valve ball, disc, and plug travel are unobstructed.
11. After piping systems have been tested and put into service, but before insulating and balancing, inspect each valve for leaks. Adjust or replace packing to stop leaks. Replace the valve if leaks persist.

3.10 ADJUSTMENT, CALIBRATION, AND TESTING

- A. Stroke and adjust control valves following manufacturer's recommended procedure, from 100 percent open to 100 percent closed back to 100 percent open.
- B. Stroke control valves with pilot positioners. Adjust valve and positioner following manufacturer's recommended procedure, so valve is 100 percent closed, 50 percent closed, and 100 percent open at proper air pressures.
- C. Check and document open and close cycle times for applications with a cycle time of less than 30 seconds.
- D. For control valves equipped with positive position indication, check feedback signal at multiple positions to confirm proper position indication.

END OF SECTION 23 09 23.33

SECTION 23 09 23.43
CONTROL DAMPERS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00.
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) requirements.

1.03 SUMMARY

- A. Section includes control dampers and actuators for DDC systems.
- B. Related Requirements:
 - 1. Section 23 09 23 “Direct-Digital Control System for HVAC” for control equipment and software, relays, electrical power devices, uninterruptible power supply units, wire, and cable.

1.04 DEFINITIONS

- A. DDC: Direct-digital control.

1.05 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings:
 - 1. Include plans, elevations, sections, and mounting details.
 - 2. Include details of product assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Include diagrams for power, signal, and control wiring.

1.06 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For control dampers to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. 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.
- B. ASME Compliance: Fabricate and label products to comply with ASME Boiler and Pressure Vessel Code where required by authorities having jurisdiction.
- C. Ground Fault: Products shall not fail due to ground fault condition when suitably grounded.
- D. Backup Power Source: Systems and equipment served by a backup power source shall have associated control damper actuators served from a backup power source.

2.02 CONTROL DAMPERS

- A. The DDC system Contractor shall furnish all automatic dampers. All automatic dampers shall be sized for the application by the DDC system Contractor or as specifically indicated on the drawings.
- B. All dampers used for throttling airflow shall be of the opposed blade type arranged for normally open or normally closed operation, as required. The damper is to be sized so that, when wide open, the pressure drop is a sufficient amount of its close-off pressure drop to shift the characteristic curve to near linear.
- C. All dampers used for two-position, open/close control shall be parallel blade type arranged for normally open or closed operation, as required.
- D. Damper frames and blades shall be constructed of either galvanized steel or aluminum. Maximum blade length in any section shall be 60". Damper blades shall be 16-gauge minimum and shall not exceed eight (8) inches in width. Damper frames shall be 16-gauge minimum hat channel type with corner bracing. All damper bearings shall be made of reinforced nylon, stainless steel or oil-impregnated bronze. Dampers shall be tight closing, low leakage type, with synthetic elastomer seals on the blade edges and flexible stainless steel side seals. Dampers of 48"x48" size shall not leak in excess of 8.0 cfm per square foot when closed against 4" WC static pressure when tested in accordance with AMCA Std. 500.
- E. Airfoil blade dampers of double skin construction with linkage out of the air stream shall be used whenever the damper face velocity exceeds 1500 FPM or system pressure exceeds 2.5" WC, but no more than 4000 FPM or 6" WC.
 - 1. Acceptable manufacturers are Johnson Controls VD-1250, VD1630, or VD-1330, Ruskin CD50 or CD60, and Vent Products 5650.
- F. One piece rolled blade dampers with exposed or concealed linkage may be used with face velocities of 1500 FPM or below.
 - 1. Acceptable manufacturers: Johnson Controls VD-1620, VD-1320, Ruskin CD36, and Vent Products 5800.

- G. Multiple section dampers may be jack-shafted to allow mounting of piston pneumatic actuators and direct connect electronic actuators. Each end of the jackshaft shall receive at least one actuator to reduce jackshaft twist.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for dampers and instruments installed in duct systems to verify actual locations of connections before installation.
- C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION, GENERAL

- A. Furnish and install products required to satisfy most stringent requirements indicated.
- B. Properly support dampers and actuators, tubing, wiring, and conduit to comply with requirements indicated. Brace all products to prevent lateral movement and sway or a break in attachment when subjected to a force.
- C. Provide ceiling, floor, roof, and wall openings and sleeves required by installation. Before proceeding with drilling, punching, or cutting, check location first for concealed products that could potentially be damaged. Patch, flash, grout, seal, and refinish openings to match adjacent condition.
- D. Seal penetrations made in fire-rated and acoustically rated assemblies.
- E. Fastening Hardware:
 - 1. Stillson wrenches, pliers, or other tools that will cause injury to or mar surfaces of rods, nuts, and other parts are prohibited for assembling and tightening nuts.
 - 2. Tighten bolts and nuts firmly and uniformly. Do not overstress threads by excessive force or by oversized wrenches.
 - 3. Lubricate threads of bolts, nuts, and screws with graphite and oil before assembly.
- F. Install products in locations that are accessible and that will permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner's access, confirm unrestricted ladder placement is possible under occupied condition.
- G. Corrosive Environments:
 - 1. Use products that are suitable for environment to which they will be subjected.
 - 2. If possible, avoid or limit use of materials in corrosive environments, including, but not limited to, the following:

- a. Salt water environment.
3. Use Type 316 stainless-steel tubing and fittings when in contact with a corrosive environment.
4. When conduit is in contact with a corrosive environment, use Type 316 stainless-steel conduit and fittings or conduit and fittings that are coated with a corrosive-resistant coating that is suitable for environment.
5. Where actuators are located in a corrosive environment and are not corrosive resistant from manufacturer, field install products in a NEMA 250, Type 4X enclosure constructed of Type 316L stainless steel.

3.03 ELECTRIC POWER

- A. Furnish and install electrical power to products requiring electrical connections.
- B. Furnish and install circuit breakers. Comply with requirements in Section 26 28 16 “Enclosed Switches and Circuit Breakers.”
- C. Furnish and install power wiring. Comply with requirements in Section 26 05 19 “Low-Voltage Electrical Power Conductors and Cables.”
- D. Furnish and install raceways. Comply with requirements in Section 26 05 33 “Raceways and Boxes for Electrical Systems.”

3.04 CONTROL DAMPERS

- A. Install smooth transitions, not exceeding 15 degrees, to dampers smaller than adjacent duct. Install transitions as close to damper as possible but at distance to avoid interference and impact to performance. Consult manufacturer for recommended clearance.
- B. Clearance:
 1. Locate dampers for easy access and provide separate support of dampers that cannot be handled by service personnel without hoisting mechanism.
 2. Install dampers with at least 24 inches of clear space on sides of dampers requiring service access.
- C. Service Access:
 1. Dampers and actuators shall be accessible for visual inspection and service.
 2. Install access door(s) in duct or equipment located upstream of damper to allow service personnel to hand clean any portion of damper, linkage, and actuator. Comply with requirements in Section 23 33 00 “Air Duct Accessories.”
- D. Install dampers straight and true, level in all planes, and square in all dimensions. Install supplementary structural steel reinforcement for large multiple-section dampers if factory support alone cannot handle loading.
- E. Attach actuator(s) to damper drive shaft.

- F. For duct-mounted and equipment-mounted dampers installed outside of equipment, install a visible and accessible indication of damper position from outside.

3.05 CONNECTIONS

- A. Connect electrical devices and components to electrical grounding system. Comply with requirements in Section 26 05 26 “Grounding and Bonding for Electrical Systems.”

3.06 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Each piece of wire, cable, and tubing shall have the same designation at each end for operators to determine continuity at points of connection. Comply with requirements for identification specified in Section 26 05 53 “Identification for Electrical Systems.”
- B. Install engraved phenolic nameplate with damper identification on damper and on face of ceiling where damper is concealed above ceiling.

3.07 CHECKOUT PROCEDURES

- A. Control-Damper Checkout:
 1. Check installed products before continuity tests, leak tests, and calibration.
 2. Check dampers for proper location and accessibility.
 3. Verify that control dampers are installed correctly for flow direction.
 4. Verify that proper blade alignment, either parallel or opposed, has been provided.
 5. Verify that damper frame attachment is properly secured and sealed.
 6. Verify that damper actuator and linkage attachment are secure.
 7. Verify that actuator wiring is complete, enclosed, and connected to correct power source.
 8. Verify that damper blade travel is unobstructed.

3.08 ADJUSTMENT, CALIBRATION, AND TESTING:

- A. Stroke and adjust control dampers following manufacturer's recommended procedure, from 100 percent open to 100 percent closed back to 100 percent open.
- B. Check and document open and close cycle times for applications with a cycle time of less than 30 seconds.
- C. For control dampers equipped with positive position indication, check feedback signal at multiple positions to confirm proper position indication.

END OF SECTION 23 09 23.43

SECTION 23 21 13
HYDRONIC PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other related Specification sections, apply to this section.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00.
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) requirements.

1.03 SUMMARY

- A. Section includes pipe and fitting materials and joining methods for the following:
 - 1. Chilled-water piping.
 - 2. Makeup-water piping.
 - 3. Condensate-drain piping.
 - 4. Air-Vent Piping.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of the following:
 - 1. Plastic pipe and fittings with solvent cement.
 - 2. RTRP and RTRF with adhesive.
 - 3. Pressure-seal fittings.
 - 4. Chemical treatment.

1.05 INFORMATIONAL SUBMITTALS

- A. Welding certificates.
- B. Field quality-control reports.

1.06 QUALITY ASSURANCE

- A. Installer Qualifications:

1. Installers of Pressure-Sealed Joints: Installers shall be certified by pressure-seal joint manufacturer as having been trained and qualified to join piping with pressure-seal pipe couplings and fittings.
- B. Steel Support Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- C. Pipe Welding: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
 1. Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation.
 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature unless otherwise indicated:
 1. Chilled-Water Piping: 150 psig at 200°F.
 2. Makeup-Water Piping: 80 psig at 150°F.
 3. Condensate-Drain Piping: 150°F.
 4. Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

2.02 COPPER TUBE AND FITTINGS

- A. Drawn-Temper Copper Tubing: ASTM B 88, Type L.
- B. Annealed-Temper Copper Tubing: ASTM B 88, Type K.
- C. DWV Copper Tubing: ASTM B 306, Type DWV.
- D. Grooved, Mechanical-Joint, Wrought-Copper Fittings: ASME B16.22.
 1. Grooved-End Copper Fittings: ASTM B 75, copper tube or ASTM B 584, bronze casting.
 2. Grooved-End-Tube Couplings: Rigid pattern unless otherwise indicated; gasketed fitting. Ductile-iron housing with keys matching pipe and fitting grooves, prelubricated EPDM gasket rated for minimum 230°F for use with housing, and steel bolts and nuts.
- E. Wrought-Copper Unions: ASME B16.22.

2.03 STEEL PIPE AND FITTINGS

- A. Steel Pipe: ASTM A 53/A 53M, black steel with plain ends; welded and seamless, Grade B, and wall thickness as indicated in “Piping Applications” Article.
- B. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125 and 250 as indicated in “Piping Applications” Article.
- C. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300 as indicated in “Piping Applications” Article.
- D. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in “Piping Applications” Article.
- E. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125, and 250; raised ground face, and bolt holes spot faced as indicated in “Piping Applications” Article.
- F. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
 - 1. Material Group: 1.1.
 - 2. End Connections: Butt welding.
 - 3. Facings: Raised face.
- G. Grooved Mechanical-Joint Fittings and Couplings:
 - 1. Joint Fittings: ASTM A 536, Grade 65-45-12 ductile iron; ASTM A 47/A 47M, Grade 32510 malleable iron; ASTM A 53/A 53M, Type F, E, or S, Grade B fabricated steel; or ASTM A 106/A 106M, Grade B steel fittings with grooves or shoulders constructed to accept grooved-end couplings; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.
 - 2. Couplings: Ductile- or malleable-iron housing and EPDM or nitrile gasket of central cavity pressure-responsive design; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.

2.04 PLASTIC PIPE AND FITTINGS

- A. CPVC Plastic Pipe: ASTM F 441/F 441M, with wall thickness as indicated in “Piping Applications” Article.
 - 1. CPVC Plastic Pipe Fittings: Socket-type pipe fittings, ASTM F 438 for Schedule 40 pipe; ASTM F 439 for Schedule 80 pipe.
- B. PVC Plastic Pipe: ASTM D 1785, with wall thickness as indicated in “Piping Applications” Article.
 - 1. PVC Plastic Pipe Fittings: Socket-type pipe fittings, ASTM D 2466 for Schedule 40 pipe; ASTM D 2467 for Schedule 80 pipe.

2.05 JOINING MATERIALS

- A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
 - 1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless otherwise indicated.
 - a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
 - b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
- B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- C. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.
- D. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- E. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BA9-1, silver alloy for joining copper with bronze or steel.
- F. 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.
- G. Solvent Cements for Joining Plastic Piping:
 - 1. CPVC Piping: ASTM F 493.
 - a. CPVC solvent cement shall have a VOC content of 490 g/L or less.
 - b. Adhesive primer shall have a VOC content of 550 g/L or less.
 - 2. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
 - a. PVC solvent cement shall have a VOC content of 510 g/L or less.
 - b. Adhesive primer shall have a VOC content of 550 g/L or less.
- H. Gasket Material: Thickness, material, and type suitable for fluid to be handled and working temperatures and pressures.

2.06 TRANSITION FITTINGS

- A. Plastic-to-Metal Transition Fittings:
 - 1. One-piece fitting with one threaded brass or copper insert and one solvent-cement-joint end of material and wall thickness to match plastic pipe material.
- B. Plastic-to-Metal Transition Unions:
 - 1. Brass or copper end, solvent-cement-joint end of material and wall thickness to match plastic pipe material, rubber gasket, and threaded union.

2.07 DIELECTRIC FITTINGS

- A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
- B. Dielectric Unions:
 - 1. Description:
 - a. Standard: ASSE 1079.
 - b. Pressure Rating: 125 psig minimum at 180°F.
 - c. End Connections: Solder-joint copper alloy and threaded ferrous.
- C. Dielectric Flanges:
 - 1. Description:
 - a. Standard: ASSE 1079.
 - b. Factory-fabricated, bolted, companion-flange assembly.
 - c. Pressure Rating: 125 psig minimum at 180°F.
 - d. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.
- D. Dielectric-Flange Insulating Kits:
 - 1. Description:
 - a. Nonconducting materials for field assembly of companion flanges.
 - b. Pressure Rating: 150 psig.
 - c. Gasket: Neoprene or phenolic.
 - d. Bolt Sleeves: Phenolic or polyethylene.
 - e. Washers: Phenolic with steel backing washers.
- E. Dielectric Nipples:
 - 1. Description:
 - a. Standard: IAPMO PS 66.
 - b. Electroplated steel nipple, complying with ASTM F 1545.
 - c. Pressure Rating: 300 psig at 225°F.
 - d. End Connections: Male threaded or grooved.

- e. Lining: Inert and noncorrosive, propylene.

PART 3 - EXECUTION

3.01 PIPING APPLICATIONS

- A. Chilled-water piping, aboveground, NPS 2 and smaller, shall be any of the following:
 - 1. Type L, drawn-temper copper tubing, wrought-copper fittings, and joints.
 - 2. Schedule 40 steel pipe; Class 150, malleable-iron fittings; cast-iron flanges and flange fittings; and threaded joints.
- B. Chilled-water piping, aboveground, NPS 2-1/2 and larger, shall be the following:
 - 1. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.
- C. Makeup-water piping installed aboveground shall be the following:
 - 1. Type L, drawn-temper copper tubing, wrought-copper fittings, and joints.
- D. Makeup-Water Piping Installed Belowground and within Slabs: Type K, annealed-temper copper tubing, wrought-copper fittings, and soldered joints. Use the fewest possible joints.
- E. Condensate-Drain Piping: Type M, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
- F. Air-Vent Piping:
 - 1. Inlet: Same as service where installed with metal-to-plastic transition fittings for plastic piping systems according to piping manufacturer's written instructions.
 - 2. Outlet: Type K, annealed-temper copper tubing with soldered or flared joints.

3.02 PIPING INSTALLATIONS

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. 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. Select system components with pressure rating equal to or greater than system operating pressure.
- K. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
- L. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.
- M. Install piping at a uniform grade of 0.2 percent upward in direction of flow.
- N. Reduce pipe sizes using eccentric reducer fitting installed with level side up.
- O. Install branch connections to mains using tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.
- P. Install valves according to Section 23 05 23.11 "Globe Valves for HVAC Piping," Section 23 05 23.12 "Ball Valves for HVAC Piping," Section 23 05 23.13 "Butterfly Valves for HVAC Piping," Section 23 05 23.14 "Check Valves for HVAC Piping," and Section 23 05 23.15 "Gate Valves for HVAC Piping."
- Q. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.
- R. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.
- S. Install shutoff valve immediately upstream of each dielectric fitting.
- T. Comply with requirements in Section 230516 "Expansion Fittings and Loops for HVAC Piping" for installation of expansion loops, expansion joints, anchors, and pipe alignment guides.
- U. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for identifying piping.
- V. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."
- W. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."
- X. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230518 "Escutcheons for HVAC Piping."

3.03 DIELECTRIC FITTING INSTALLATION

- A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
- B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric nipples or unions.
- C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges, nipples, or unions.
- D. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.04 HANGERS AND SUPPORTS

- A. Comply with requirements in Section 23 05 29 “Hangers and Supports for HVAC Piping and Equipment” for hanger, support, and anchor devices. Comply with the following requirements for maximum spacing of supports.
- B. Comply with requirements in Section 23 05 48 “Vibration and Seismic Controls for HVAC” for seismic restraints.
- C. Install the following pipe attachments:
 - 1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.
 - 2. Spring hangers to support vertical runs.
 - 3. Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
 - 4. On plastic pipe, install pads or cushions on bearing surfaces to prevent hanger from scratching pipe.
- D. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:
 - 1. NPS 3/4: Maximum span, 7 feet.
 - 2. NPS 1: Maximum span, 7 feet.
 - 3. NPS 1-1/2: Maximum span, 9 feet.
 - 4. NPS 2: Maximum span, 10 feet.
 - 5. NPS 2-1/2: Maximum span, 11 feet.
 - 6. NPS 3 and Larger: Maximum span, 12 feet.
- E. Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:
 - 1. NPS 3/4: Maximum span, 5 feet; minimum rod size, 1/4 inch.
 - 2. NPS 1: Maximum span, 6 feet; minimum rod size, 1/4 inch.
 - 3. NPS 1-1/4: Maximum span, 7 feet; minimum rod size, 3/8 inch.

4. NPS 1-1/2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
 5. NPS 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
 6. NPS 2-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
 7. NPS 3 and Larger: Maximum span, 10 feet; minimum rod size, 3/8 inch.
- F. Plastic Piping Hanger Spacing: Space hangers according to pipe manufacturer's written instructions for service conditions. Avoid point loading. Space and install hangers with the fewest practical rigid anchor points.
- G. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.

3.05 PIPE JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- D. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8/A5.8M.
- E. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 2. 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.
- F. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.
- G. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
- H. Plastic Piping Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
 1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
 2. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.

3. PVC Pressure Piping: Join ASTM D 1785 schedule number, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule number PVC pipe and socket fittings according to ASTM D 2855.
4. PVC Nonpressure Piping: Join according to ASTM D 2855.
- I. Grooved Joints: Assemble joints with coupling and gasket, lubricant, and bolts. Cut or roll grooves in ends of pipe based on pipe and coupling manufacturer's written instructions for pipe wall thickness. Use grooved-end fittings and rigid, grooved-end-pipe couplings.
- J. Mechanically Formed, Copper-Tube-Outlet Joints: Use manufacturer-recommended tool and procedure, and brazed joints.

3.06 TERMINAL EQUIPMENT CONNECTIONS

- A. Sizes for supply and return piping connections shall be the same as or larger than equipment connections.
- B. Install control valves in accessible locations close to connected equipment.
- C. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.
- D. Install ports for pressure gages and thermometers at coil inlet and outlet connections. Comply with requirements in Section 23 05 19 "Meters and Gages for HVAC Piping."

3.07 FIELD QUALITY CONTROL

- A. Prepare hydronic piping according to ASME B31.9 and as follows:
 1. Leave joints, including welds, uninsulated and exposed for examination during test.
 2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
 3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
 4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
 5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.
- B. Perform the following tests on hydronic piping:
 1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.

2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
 3. Isolate expansion tanks and determine that hydronic system is full of water.
 4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times the "SE" value in Appendix A in ASME B31.9, "Building Services Piping."
 5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
 6. Prepare written report of testing.
- C. Perform the following before operating the system:
1. Open manual valves fully.
 2. Inspect pumps for proper rotation.
 3. Set makeup pressure-reducing valves for required system pressure.
 4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
 5. Set temperature controls so all coils are calling for full flow.
 6. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
 7. Verify lubrication of motors and bearings.

END OF SECTION 23 21 13

SECTION 23 21 13.13
UNDERGROUND HYDRONIC PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00.
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) requirements.

1.03 SUMMARY

- A. Section Includes:
 - 1. Steel pipes and fittings.
 - 2. Cased piping system.

1.04 PERFORMANCE REQUIREMENTS

- A. Provide components and installation capable of producing hydronic piping systems with the following minimum working-pressure ratings:
 - 1. Chilled-Water Piping: 150 psig at 200°F.

1.05 ACTION SUBMITTALS

- A. Product Data: For the following:
 - 1. Cased piping.
- B. Shop Drawings: For underground hydronic piping. Signed and sealed by a professional engineer registered in the State of Florida.
 - 1. Calculate requirements for expansion compensation for underground piping.
 - 2. Show expansion compensators, offsets, and loops with appropriate materials to allow piping movement in the required locations. Show anchors and guides that restrain piping movement with calculated loads, and show concrete thrust block dimensions.
 - 3. Show pipe sizes, locations, and elevations. Show piping in trench, conduit, and cased pipe with details showing clearances between piping, and show insulation thickness.

1.06 INFORMATIONAL SUBMITTALS

- A. Profile Drawings: Show system piping in elevation. Draw profiles at horizontal scale of not less than 1 inch equals 50 feet and at vertical scale of not less than 1 inch equals 5 feet. Indicate manholes and piping. Show types, sizes, materials, and elevations of other utilities crossing hydronic piping.
- B. Qualification Data: For qualified Installer.
- C. Welding certificates.
- D. Material Test Reports: For cased piping.
- E. Source quality-control reports.
- F. Field quality-control reports.

1.07 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX.
 - 1. Comply with provisions in ASME B31.9, "Building Services Piping."
 - 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
- B. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation.

PART 2 - PRODUCTS

2.01 STEEL PIPES AND FITTINGS

- A. Steel Pipe: ASTM A 53/A 53M, black with plain ends; type, grade, and wall thickness as indicated in "Piping Application" Article.
- B. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Class 125; raised ground face, and bolt holes spot faced.
- C. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.
- D. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
 - 1. Material Group: 1.1.
 - 2. End Connections: Butt welding.
 - 3. Facings: Raised face.
- E. Steel Welding Fittings: ASME B16.9 and ASTM A 234/A 234M, seamless or welded.
 - 1. 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.

- F. Nipples: ASTM A 733, made of same materials and wall thicknesses as pipe in which they are installed.
- G. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
 - 1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
 - a. Full-Face Type: For flat-face, Class 125, cast-iron and -bronze flanges.
 - b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
- H. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

2.02 PLASTIC PIPE AND FITTINGS

- A. PVC Plastic:
 - 1. Pipe: ASTM D 1785, Schedules 40 and 80, plain ends as indicated in “Piping Application” Article.
 - 2. Pipe Fittings: Socket-type pipe fittings, ASTM D 2466 for Schedule 40 pipe; ASTM D 2467 for Schedule 80 pipe.
 - 3. Solvent Cements: ASTM D 2564. Include primer according to ASTM F 656.
 - a. Use PVC solvent cement that has a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - b. Use adhesive primer that has a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.03 CASED PIPING SYSTEM

- A. Description: Factory-fabricated piping with carrier pipe, insulation, and casing.
- B. Carrier Pipe: Schedule 40, steel pipe and fittings.
- C. Carrier Pipe Insulation:
 - 1. Polyurethane Foam Pipe Insulation: Rigid, cellular, high-pressure injected between carrier pipe and jacket.
 - a. Comply with ASTM C 591; thermal conductivity (k-value) shall not exceed 0.14 Btu x in./h x sq. ft. x°F at 75°F after 180 days of aging.
- D. Casing: PVC.
- E. Casing accessories include the following:
 - 1. Joint Kit: Half-shell, pourable or split insulation, casing sleeve, and shrink-wrap sleeve.

2. End Seals: Shrink wrap the casing material to seal watertight around casing and carrier pipe.
- F. Source Quality Control: Factory test the carrier pipe to 150 percent of the operating pressure of system. Furnish test certificates.

PART 3 - EXECUTION

3.01 EARTHWORK

- A. See Section 31 20 00 "Earth Moving" for excavating, trenching, and backfilling.

3.02 PIPING APPLICATION

A. Chilled-Water Piping:

1. NPS 2-1/2 and larger shall be the following:
 - a. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.
2. Cased piping with polyurethane carrier-pipe insulation.
 - a. Piping Insulation Thickness: 2 inches.

3.03 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicate piping locations and arrangements if such were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- B. Remove standing water in the bottom of trench.
- C. Do not backfill piping trench until field quality-control testing has been completed and results approved.
- D. Install piping at uniform grade of 0.2 percent. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points and elsewhere as required for system drainage. Install manual air vents at high points.
- E. In conduits, install drain valves at low points and manual air vents at high points.
- F. Install components with pressure rating equal to or greater than system operating pressure.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. See Section 23 05 17 "Sleeves and Sleeve Seals for HVAC Piping" for sleeves and mechanical sleeve seals through exterior building walls.
- J. Secure anchors with concrete thrust blocks. Concrete is specified in Section 03 30 00 "Cast-in-Place Concrete."

3.04 JOINT CONSTRUCTION

- A. See Section 33 050 0 “Common Work Results for Utilities” for basic piping joint construction.
- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to “Quality Assurance” Article.
- E. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
- F. Plastic Piping Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
 - 1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
 - 2. PVC Pressure Piping: Join ASTM D 1785 schedule number, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule number PVC pipe and socket fittings according to ASTM D 2855.
- G. Pressure-Sealed Joints: Use manufacturer-recommended tool and procedure. Leave insertion marks on pipe after assembly.
- H. Conduit and Cased Piping Joints: Assemble sections and finish joints with pourable or split insulation and exterior jacket sleeve, and apply shrink-wrap seals.

3.05 IDENTIFICATION

- A. Install continuous plastic underground warning tapes during back filling of trenches for underground hydronic piping. Locate tapes 6 to 8 inches below finished grade, directly over piping. See Section 31 20 00 “Earth Moving” for warning-tape materials and devices and their installation.

3.06 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Tests and Inspections:
 - 1. Prepare hydronic piping for testing according to ASME B31.9 and as follows:
 - a. Leave joints, including welds, uninsulated and exposed for examination during test.

- b. Fill system with water.
 - c. Use vents installed at high points to release trapped air while filling system.
 - 2. Test hydronic piping as follows:
 - a. Subject hydronic piping to hydrostatic test pressure that is not less than 1.5 times the design pressure.
 - b. After hydrostatic test pressure has been applied for 10 minutes, examine joints for leakage. Remake leaking joints using new materials and repeat hydrostatic test until no leaks exist.
- C. Prepare test and inspection reports.

END OF SECTION 23 21 13.13

SECTION 23 21 16
HYDRONIC PIPING SPECIALTIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00.
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) requirements.

1.03 SUMMARY

- A. Section includes special-duty valves and specialties for the following:
 - 1. Chilled-water piping.
 - 2. Makeup-water piping.
 - 3. Air-vent piping.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of the following:
 - 1. Valves: Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.
 - 2. Air-control devices.
 - 3. Hydronic specialties.

1.05 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For air-control devices, hydronic specialties, and special-duty valves to include in emergency, operation, and maintenance manuals.

1.06 MAINTENANCE MATERIAL SUBMITTALS

- A. Differential Pressure Meter: For each type of balancing valve and automatic flow control valve, include flowmeter, probes, hoses, flow charts, and carrying case.

1.07 QUALITY ASSURANCE

- A. Pipe Welding: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

1. Pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature unless otherwise indicated:
 1. Chilled-Water Piping: 150 psig at 200°F.
 2. Makeup-Water Piping: 80 psig at 150°F.
 3. Air-Vent Piping: 200°F.

2.02 VALVES

- A. Gate, Globe, Check, Ball, and Butterfly Valves: Comply with requirements specified in Section 23 05 23.12 "Ball Valves for HVAC Piping," Section 23 05 23.13 "Butterfly Valves for HVAC Piping," Section 23 05 23.14 "Check Valves for HVAC Piping," and Section 23 05 23.15 "Gate Valves for HVAC Piping."
- B. Automatic Temperature-Control Valves, Actuators, and Sensors: Comply with requirements specified in Section 23 09 23.11 "Control Valves."
- C. Bronze, Calibrated-Orifice, Balancing Valves:
 1. Body: Bronze, ball or plug type with calibrated orifice or venturi.
 2. Ball: Brass or stainless steel.
 3. Plug: Resin.
 4. Seat: PTFE.
 5. End Connections: Threaded or socket.
 6. Pressure Gage Connections: Integral seals for portable differential pressure meter.
 7. Handle Style: Lever, with memory stop to retain set position.
 8. CWP Rating: Minimum 125 psig (860 kPa).
 9. Maximum Operating Temperature: 250°F (121°C).
- D. Cast-Iron or Steel, Calibrated-Orifice, Balancing Valves:
 1. Body: Cast-iron or steel body, ball, plug, or globe pattern with calibrated orifice or venturi.
 2. Ball: Brass or stainless steel.
 3. Stem Seals: EPDM O-rings.

4. Disc: Glass and carbon-filled PTFE.
5. Seat: PTFE.
6. End Connections: Flanged or grooved.
7. Pressure Gage Connections: Integral seals for portable differential pressure meter.
8. Handle Style: Lever, with memory stop to retain set position.
9. CWP Rating: Minimum 125 psig (860 kPa).
10. Maximum Operating Temperature: 250°F (121°C).

E. Diaphragm-Operated, Pressure-Reducing Valves: ASME labeled.

1. Body: Bronze or brass.
2. Disc: Glass and carbon-filled PTFE.
3. Seat: Brass.
4. Stem Seals: EPDM O-rings.
5. Diaphragm: EPT.
6. Low inlet-pressure check valve.
7. Inlet Strainer: Stainless steel, removable without system shutdown.
8. Valve Seat and Stem: Noncorrosive.
9. Valve Size, Capacity, and Operating Pressure: Selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

F. Automatic Flow-Control Valves:

1. Body: Brass or ferrous metal.
2. Piston and Spring Assembly: Stainless steel, tamper proof, self-cleaning, and removable.
3. Combination Assemblies: Include bronze or brass-alloy ball valve.
4. Identification Tag: Marked with zone identification, valve number, and flow rate.
5. Size: Same as pipe in which installed.
6. Performance: Maintain constant flow, plus or minus 5 percent over system pressure fluctuations.
7. Minimum CWP Rating: 175 psig.
8. Maximum Operating Temperature: 200°F

2.03 AIR-CONTROL DEVICES

A. Manual Air Vents:

1. Body: Bronze.
2. Internal Parts: Nonferrous.
3. Operator: Screwdriver or thumbscrew.
4. Inlet Connection: NPS 1/2 (DN 15).
5. Discharge Connection: NPS 1/8 (DN 6).
6. CWP Rating: 150 psig (1035 kPa).
7. Maximum Operating Temperature: 225°F (107°C).

B. Automatic Air Vents:

1. Body: Bronze or cast iron.
2. Internal Parts: Nonferrous.
3. Operator: Noncorrosive metal float.
4. Inlet Connection: NPS 1/2 (DN 15).
5. Discharge Connection: NPS 1/4 (DN 8).
6. CWP Rating: 150 psig (1035 kPa).
7. Maximum Operating Temperature: 240°F (116°C).

C. Diaphragm-Type Expansion Tanks:

1. Tank: Welded steel, rated for 125-psig (860-kPa) working pressure and 375°F (191°C) maximum operating temperature. Factory test after taps are fabricated and supports installed and are labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
2. Diaphragm: Securely sealed into tank to separate air charge from system water to maintain required expansion capacity.
3. Air-Charge Fittings: Schrader valve, stainless steel with EPDM seats.

D. Tangential-Type Air Separators:

1. Tank: Welded steel; ASME constructed and labeled for 125-psig (860-kPa) minimum working pressure and 375°F (191°C) maximum operating temperature.
2. Air Collector Tube: Perforated stainless steel, constructed to direct released air into expansion tank.

3. Tangential Inlet and Outlet Connections: Threaded for NPS 2 (DN 50) and smaller; flanged connections for NPS 2-1/2 (DN 65) and larger.
4. Blowdown Connection: Threaded.
5. Size: Match system flow capacity.

2.04 HYDRONIC PIPING SPECIALTIES

A. Y-Pattern Strainers:

1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 (DN 50) and smaller; flanged ends for NPS 2-1/2 (DN 65) and larger.
3. Strainer Screen: Stainless-steel, 20-mesh strainer, or perforated stainless-steel basket.
4. CWP Rating: 125 psig (860 kPa).

B. Spherical, Rubber, Flexible Connectors:

1. Body: Fiber-reinforced rubber body.
2. End Connections: Steel flanges drilled to align with Classes 150 and 300 steel flanges.
3. Performance: Capable of misalignment.
4. CWP Rating: 150 psig (1035 kPa).
5. Maximum Operating Temperature: 250°F (121°C).

PART 3 - EXECUTION

3.01 VALVE APPLICATIONS

- A. Install shutoff-duty valves at each branch connection to supply mains and at supply connection to each piece of equipment.
- B. Install calibrated-orifice, balancing valves at each branch connection to return main.
- C. Install calibrated-orifice, balancing valves in the return pipe of each cooling terminal.
- D. Install check valves at each pump discharge and elsewhere as required to control flow direction.
- E. Install pressure-reducing valves at makeup-water connection to regulate system fill pressure.

3.02 HYDRONIC SPECIALTIES INSTALLATION

- A. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.
- B. Install automatic air vents at high points of system piping in mechanical equipment rooms only. Install manual vents at heat-transfer coils and elsewhere as required for air venting.
- C. Install tangential air separator in pump suction. Install blowdown piping with gate or full-port ball valve; extend full size to nearest floor drain.
- D. Install expansion tanks on the floor. Vent and purge air from hydronic system, and ensure that tank is properly charged with air to suit system Project requirements.

END OF SECTION 23 21 16

SECTION 23 21 23
HYDRONIC PUMPS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00.
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) requirements.

1.03 SUMMARY

- A. Section Includes:
 - 1. Separately coupled, base-mounted, end-suction centrifugal pumps.

1.04 DEFINITIONS

- A. Buna-N: Nitrile rubber.
- B. EPT: Ethylene propylene terpolymer.

1.05 ACTION SUBMITTALS

- A. Product Data: For each type of pump. Include certified performance curves and rated capacities, operating characteristics, furnished specialties, final impeller dimensions, and accessories for each type of product indicated. Indicate pump's operating point on curves.
- B. Shop Drawings: For each pump.
 - 1. Show pump layout and connections.
 - 2. Include setting drawings with templates for installing foundation and anchor bolts and other anchorages.
 - 3. Include diagrams for power, signal, and control wiring.

1.06 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For pumps to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.01 SEPARATELY COUPLED, BASE-MOUNTED, END-SUCTION CENTRIFUGAL PUMPS

- A. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, separately coupled, end-suction pump as defined in HI 1.1-1.2 and HI 1.3; designed for base mounting, with pump and motor shafts horizontal.
- B. Pump Construction:
 - 1. Casing: Radially split, cast iron, with threaded gage tappings at inlet and outlet, drain plug at bottom and air vent at top of volute, and flanged connections. Provide integral mount on volute to support the casing, and provide attached piping to allow removal and replacement of impeller without disconnecting piping or requiring the realignment of pump and motor shaft.
 - 2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. For pumps not frequency-drive controlled, trim impeller to match specified performance.
 - 3. Pump Shaft: Stainless steel.
 - 4. Seal: Mechanical seal consisting of carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N bellows and gasket.
 - 5. Pump Bearings: Grease-lubricated ball bearings in cast-iron housing with grease fittings.
- C. Shaft Coupling: Molded-rubber insert and interlocking spider capable of absorbing vibration. Couplings shall be drop-out type to allow disassembly and removal without removing pump shaft or motor. EPDM coupling sleeve for variable-speed applications.
- D. Coupling Guard: Dual rated; ANSI B15.1, Section 8; OSHA 1910.219 approved; steel; removable; attached to mounting frame.
- E. Mounting Frame: Welded-steel frame and cross members, factory fabricated from ASTM A 36/A 36M channels and angles. Fabricate to mount pump casing, coupling guard, and motor.
- F. Motor: Single speed, secured to mounting frame, with adjustable alignment.
 - 1. 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. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
 - a. Enclosure: Open, dripproof.
 - b. Motor Bearings: Grease-lubricated ball bearings.
 - c. Efficiency: Premium efficient.

2.02 PUMP SPECIALTY FITTINGS

- A. Suction Diffuser:
 - 1. Angle pattern.
 - 2. 175-psig pressure rating, **cast-iron** body and end cap, pump-inlet fitting.
 - 3. Bronze startup and bronze or stainless-steel permanent strainers.
 - 4. Bronze or stainless-steel straightening vanes.
 - 5. Drain plug.
 - 6. Factory-fabricated support.

2.03 MANUFACTURER

- A. Subject to compliance with requirements, provide frame-mounted end suction pumps of one of the following:
 - 1. Armstrong Pumps, Inc.
 - 2. Aurora Pump; Unit of General Signal.
 - 3. Bell & Gossett ITT; Fluid Handling Div.
 - 4. Peerless Pump; Indian Head Co.
 - 5. Weinman Pump LFE Corp.; Fluids Control Div.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.
- C. Examine foundations and inertia bases for suitable conditions where pumps are to be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PUMP INSTALLATION

- A. Comply with HI 1.4.
- B. Install pumps to provide access for periodic maintenance including removing motors, impellers, couplings, and accessories.

- C. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.
- D. Equipment Mounting:
 - 1. Install base-mounted pumps on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
 - 2. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

3.03 ALIGNMENT

- A. Perform alignment service.
- B. Comply with requirements in Hydronics Institute standards for alignment of pump and motor shaft. Add shims to the motor feet and bolt motor to base frame. Do not use grout between motor feet and base frame.
- C. Comply with pump and coupling manufacturers' written instructions.
- D. After alignment is correct, tighten foundation bolts evenly but not too firmly. Completely fill baseplate with nonshrink, nonmetallic grout while metal blocks and shims or wedges are in place. After grout has cured, fully tighten foundation bolts.

3.04 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where installing piping adjacent to pump, allow space for service and maintenance.
- C. Connect piping to pumps. Install valves that are same size as piping connected to pumps.
- D. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.
- E. Install check valve and shutoff valve on discharge side of pumps.
- F. Install suction diffuser and shutoff valve on suction side of pumps.
- G. Install flexible connectors on suction and discharge sides of base-mounted pumps between pump casing and valves.
- H. Install pressure gages on pump suction and discharge or at integral pressure-gage tapping, or install single gage with multiple-input selector valve.
- I. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."
- J. Connect wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

3.05 STARTUP SERVICE

- A. Perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.
 - 2. Check piping connections for tightness.
 - 3. Clean strainers on suction piping.
 - 4. Perform the following startup checks for each pump before starting:
 - a. Verify bearing lubrication.
 - b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
 - c. Verify that pump is rotating in the correct direction.
 - 5. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
 - 6. Start motor.
 - 7. Open discharge valve slowly.

3.06 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain hydronic pumps.

END OF SECTION 23 21 23

SECTION 23 23 00
REFRIGERANT PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other related Specification sections, apply to this section.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00.
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) requirements.

1.03 SUMMARY

- A. Section Includes:
 - 1. Refrigerant pipes and fittings.
 - 2. Refrigerant piping valves and specialties.
 - 3. Refrigerants.

1.04 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.05 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.

1.06 QUALITY ASSURANCE

- A. Comply with ASHRAE 15, “Safety Code for Refrigeration Systems.”
- B. Comply with ASME B31.5, “Refrigeration Piping and Heat Transfer Components.”

1.07 PRODUCT STORAGE AND HANDLING

- A. Store piping with end caps in place to ensure that piping interior and exterior are clean when installed.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Line Test Pressure for Refrigerant R-410A:

1. Suction Lines for Air-Conditioning Applications: 300 psig.
2. Suction Lines for Heat-Pump Applications: 535 psig.
3. Hot-Gas and Liquid Lines: 535 psig.

2.02 COPPER TUBE AND FITTINGS

- A. Copper Tube: ASTM B 88, Type K or L or ASTM B 280, Type ACR.
- B. Wrought-Copper Fittings: ASME B16.22.
- C. Wrought-Copper Unions: ASME B16.22.
- D. Solder Filler Metals: ASTM B 32. Use 95-5 tin antimony or alloy HB solder to join copper socket fittings on copper pipe.
- E. Brazing Filler Metals: AWS A5.8/A5.8M.
- F. Flexible Connectors:
 1. Body: Tin-bronze bellows with woven, flexible, tinned-bronze-wire-reinforced protective jacket.
 2. End Connections: Socket ends.
 3. Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch-long assembly.
 4. Working Pressure Rating: Factory test at minimum 500 psig.
 5. Maximum Operating Temperature: 250°F.

2.03 VALVES AND SPECIALTIES

- A. Diaphragm Packless Valves:
 1. Body and Bonnet: Forged brass or cast bronze; globe design with straight-through or angle pattern.
 2. Diaphragm: Phosphor bronze and stainless steel with stainless-steel spring.
 3. Operator: Rising stem and hand wheel.
 4. Seat: Nylon.
 5. End Connections: Socket, union, or flanged.
 6. Working Pressure Rating: 500 psig.
 7. Maximum Operating Temperature: 275°F.
- B. Packed-Angle Valves:
 1. Body and Bonnet: Forged brass or cast bronze.

2. Packing: Molded stem, back seating, and replaceable under pressure.
3. Operator: Rising stem.
4. Seat: Nonrotating, self-aligning polytetrafluoroethylene.
5. Seal Cap: Forged-brass or valox hex cap.
6. End Connections: Socket, union, threaded, or flanged.
7. Working Pressure Rating: 500 psig.
8. Maximum Operating Temperature: 275°F.

C. Check Valves:

1. Body: Ductile iron, forged brass, or cast bronze; globe pattern.
2. Bonnet: Bolted ductile iron, forged brass, or cast bronze; or brass hex plug.
3. Piston: Removable polytetrafluoroethylene seat.
4. Closing Spring: Stainless steel.
5. End Connections: Socket, union, threaded, or flanged.
6. Maximum Opening Pressure: 0.50 psig.
7. Working Pressure Rating: 500 psig.
8. Maximum Operating Temperature: 275°F.

D. Service Valves:

1. Body: Forged brass with brass cap including key end to remove core.
2. Core: Removable ball-type check valve with stainless-steel spring.
3. Seat: Polytetrafluoroethylene.
4. End Connections: Copper spring.
5. Working Pressure Rating: 500 psig.

E. Solenoid Valves: Comply with AHRI 760 and UL 429; listed and labeled by a National Recognized Testing Laboratory (NRTL).

1. Body and Bonnet: Plated steel.
2. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
3. Seat: Polytetrafluoroethylene.
4. End Connections: Threaded.

5. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter, and coil.
 6. Working Pressure Rating: 400 psig.
 7. Maximum Operating Temperature: 240°F.
- F. Safety Relief Valves: Comply with 2010 ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.
1. Body and Bonnet: Ductile iron and steel, with neoprene O-ring seal.
 2. Piston, Closing Spring, and Seat Insert: Stainless steel.
 3. Seat: Polytetrafluoroethylene.
 4. End Connections: Threaded.
 5. Working Pressure Rating: 400 psig.
 6. Maximum Operating Temperature: 240°F.
- G. Thermostatic Expansion Valves: Comply with AHRI 750.
1. Body, Bonnet, and Seal Cap: Forged brass or steel.
 2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
 3. Packing and Gaskets: Non-asbestos.
 4. Capillary and Bulb: Copper tubing filled with refrigerant charge.
 5. Suction Temperature: See schedule on drawing.
 6. Superheat: Adjustable.
 7. Reverse-flow option (for heat-pump applications).
 8. End Connections: Socket, flare, or threaded union.
 9. Working Pressure Rating: 700 psig.
- H. Hot-Gas Bypass Valves: Comply with UL 429; listed and labeled by an NRTL.
1. Body, Bonnet, and Seal Cap: Ductile iron or steel.
 2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
 3. Packing and Gaskets: Non-asbestos.
 4. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
 5. Seat: Polytetrafluoroethylene.
 6. Equalizer: Internal or External.

7. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter and coil.
 8. End Connections: Socket.
 9. Throttling Range: Maximum 5 psig.
 10. Working Pressure Rating: 500 psig.
 11. Maximum Operating Temperature: 240°F.
- I. Straight-Type Strainers:
1. Body: Welded steel with corrosion-resistant coating.
 2. Screen: 100-mesh stainless steel.
 3. End Connections: Socket or flare.
 4. Working Pressure Rating: 500 psig.
 5. Maximum Operating Temperature: 275°F.
- J. Angle-Type Strainers:
1. Body: Forged brass or cast bronze.
 2. Drain Plug: Brass hex plug.
 3. Screen: 100-mesh monel.
 4. End Connections: Socket or flare.
 5. Working Pressure Rating: 500 psig.
 6. Maximum Operating Temperature: 275°F.
- K. Moisture/Liquid Indicators:
1. Body: Forged brass.
 2. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.
 3. Indicator: Color coded to show moisture content in parts per million (ppm).
 4. Minimum Moisture Indicator Sensitivity: Indicate moisture above 60 ppm.
 5. End Connections: Socket or flare.
 6. Working Pressure Rating: 500 psig.
 7. Maximum Operating Temperature: 240°F.
- L. Replaceable-Core Filter Dryers: Comply with AHRI 730.

1. Body and Cover: Painted-steel shell with ductile-iron cover, stainless-steel screws, and neoprene gaskets.
 2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
 3. Desiccant Media: Activated alumina.
 4. Designed for reverse flow (for heat-pump applications).
 5. End Connections: Socket.
 6. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.
 7. Maximum Pressure Loss: 2 psig.
 8. Working Pressure Rating: 500 psig.
 9. Maximum Operating Temperature: 240°F.
- M. Permanent Filter Dryers: Comply with AHRI 730.
1. Body and Cover: Painted-steel shell.
 2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
 3. Desiccant Media: Activated alumina.
 4. Designed for reverse flow (for heat-pump applications).
 5. End Connections: Socket.
 6. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.
 7. Maximum Pressure Loss: 2 psig.
 8. Working Pressure Rating: 500 psig.
 9. Maximum Operating Temperature: 240°F.
- N. Mufflers:
1. Body: Welded steel with corrosion-resistant coating.
 2. End Connections: Socket or flare.
 3. Working Pressure Rating: 500 psig.
 4. Maximum Operating Temperature: 275°F.
- O. Receivers: Comply with AHRI 495.
1. Comply with UL 207; listed and labeled by an NRTL.

2. Body: Welded steel with corrosion-resistant coating.
 3. Tappings: Inlet, outlet, liquid level indicator, and safety relief valve.
 4. End Connections: Socket or threaded.
 5. Working Pressure Rating: 500 psig.
 6. Maximum Operating Temperature: 275°F.
- P. Liquid Accumulators: Comply with AHRI 495.
1. Body: Welded steel with corrosion-resistant coating.
 2. End Connections: Socket or threaded.
 3. Working Pressure Rating: 500 psig.
 4. Maximum Operating Temperature: 275°F.

2.04 REFRIGERANTS

- A. ASHRAE 34, R-410A: Pentafluoroethane/Difluoromethane.

PART 3 - EXECUTION

3.01 PIPING APPLICATIONS FOR REFRIGERANT R-410A

- A. Suction Lines for Conventional Air-Conditioning Applications: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed joints.
- B. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications: Copper, Type ACR, annealed- or drawn-temper tubing and wrought-copper fittings with brazed joints.
- C. Safety-Relief-Valve Discharge Piping: Copper, Type K, annealed- or drawn-temper tubing and wrought-copper fittings with brazed joints.

3.02 VALVE AND SPECIALTY APPLICATIONS

- A. A factory authorized representative or the equipment manufacturer shall review the plans and provide the appropriate refrigerant specialty items to render the system completely serviceable, Items listed herein may or may not be applicable to the equipment furnished by any particular manufacturer.
1. Install service valves for gage taps at inlet and outlet of hot-gas bypass valves and strainers if they are not an integral part of valves and strainers.
 2. Install a check valve at the compressor discharge and a liquid accumulator at the compressor suction connection.
 3. Except as otherwise indicated, install valves on inlet and outlet side of filter dryers.
 4. Install a full-size, three-valve bypass around filter dryers.

5. Install solenoid valves upstream from each expansion valve and hot-gas bypass valve. Install solenoid valves in horizontal lines with coil at top.
6. Install thermostatic expansion valves as close as possible to distributors on evaporators.
 - a. Install valve so diaphragm case is warmer than bulb.
 - b. Secure bulb to clean, straight, horizontal section of suction line using two bulb straps. Do not mount bulb in a trap or at bottom of the line.
 - c. If external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.
7. Install safety relief valves where required by 2010 ASME Boiler and Pressure Vessel Code. Pipe safety-relief-valve discharge line to outside according to ASHRAE 15.
8. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.
9. Install strainers upstream from and adjacent to the following unless they are furnished as an integral assembly for the device being protected:
 - a. Solenoid valves.
 - b. Thermostatic expansion valves.
 - c. Hot-gas bypass valves.
 - d. Compressor.
10. Install filter dryers in liquid line between compressor and thermostatic expansion valve, and in the suction line at the compressor.
11. Install receivers sized to accommodate pump-down charge.
12. Install flexible connectors at compressors.

3.03 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems; indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings.
- B. Install refrigerant piping according to ASHRAE 15.
- C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- D. 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.

- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping adjacent to machines to allow service and maintenance.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Select system components with pressure rating equal to or greater than system operating pressure.
- J. Refer to Section 23 09 23 “Direct Digital Control (DDC) System for HVAC” and Section 23 09 93.11 “Sequence of Operations for HVAC DDC” for solenoid valve controllers, control wiring, and sequence of operation.
- K. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.
- L. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as specified in Section 08 31 13 “Access Doors and Frames” if valves or equipment requiring maintenance is concealed behind finished surfaces.
- M. Install refrigerant piping in protective conduit where installed belowground.
- N. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.
- O. Slope refrigerant piping as follows:
 - 1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
 - 2. Install horizontal suction lines with a uniform slope downward to compressor.
 - 3. Install traps and double risers to entrain oil in vertical runs.
 - 4. Liquid lines may be installed level.
- P. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.
- Q. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.
- R. Identify refrigerant piping and valves according to Section 23 05 53 “Identification for HVAC Piping and Equipment.”
- S. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 23 05 17 “Sleeves and Sleeve Seals for HVAC Piping.”

- T. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 23 05 17 “Sleeves and Sleeve Seals for HVAC Piping.”
- U. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 23 05 18 “Escutcheons for HVAC Piping.”

3.04 PIPE JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Soldered Joints: Construct joints according to ASTM B 828 or CDA's “Copper Tube Handbook.”
- D. Brazed Joints: Construct joints according to AWS's “Brazing Handbook,” Chapter “Pipe and Tube.”
 - 1. Use Type BCuP (copper-phosphorus) alloy for joining copper socket fittings with copper pipe.
 - 2. Use Type BAg (cadmium-free silver) alloy for joining copper with bronze or steel.
- E. Threaded Joints: Thread steel pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and to restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads unless dry-seal threading is specified.
 - 2. 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.
- F. Steel pipe can be threaded, but threaded joints must be seal brazed or seal welded.
- G. Welded Joints: Construct joints according to AWS D10.12M/D10.12.
- H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.05 HANGERS AND SUPPORTS

- A. Comply with requirements for pipe hangers and supports specified in Section 23 05 29 “Hangers and Supports for HVAC Piping and Equipment.”
- B. Install the following pipe attachments:
 - 1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet long.

2. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
- C. Install hangers for copper tubing with the following maximum spacing and minimum rod diameters:
1. NPS 1/2: Maximum span, 60 inches; minimum rod, 1/4 inch.
 2. NPS 5/8: Maximum span, 60 inches; minimum rod, 1/4 inch.
 3. NPS 1: Maximum span, 72 inches; minimum rod, 1/4 inch.
 4. NPS 1-1/4: Maximum span, 96 inches; minimum rod, 3/8 inch.
 5. NPS 1-1/2: Maximum span, 96 inches; minimum rod, 3/8 inch.
 6. NPS 2: Maximum span, 96 inches; minimum rod, 3/8 inch.
 7. NPS 2-1/2: Maximum span, 108 inches; minimum rod, 3/8 inch.
 8. NPS 3: Maximum span, 10 feet; minimum rod, 3/8 inch.
 9. NPS 4: Maximum span, 12 feet; minimum rod, 1/2 inch.
- D. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 2: Maximum span, 10 feet; minimum rod, 3/8 inch.
 2. NPS 2-1/2: Maximum span, 11 feet; minimum rod, 3/8 inch.
 3. NPS 3: Maximum span, 12 feet; minimum rod, 3/8 inch.
 4. NPS 4: Maximum span, 14 feet; minimum rod, 1/2 inch.
- E. Support multifloor vertical runs at least at each floor.

3.06 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
1. Comply with ASME B31.5, Chapter VI.
 2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
 3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in "Performance Requirements" Article.
 - a. Fill system with nitrogen to the required test pressure.
 - b. System shall maintain test pressure at the manifold gage throughout duration of test.

- c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
 - d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.
- B. Prepare test and inspection reports.

3.07 SYSTEM CHARGING

- A. Charge system using the following procedures:
- 1. Install core in filter dryers after leak test but before evacuation.
 - 2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers. If vacuum holds for 12 hours, system is ready for charging.
 - 3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.
 - 4. Charge system with a new filter-dryer core in charging line.

3.08 ADJUSTING

- A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.
- B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.
- C. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.
- D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:
- 1. Open shutoff valves in condenser water circuit.
 - 2. Verify that compressor oil level is correct.
 - 3. Open compressor suction and discharge valves.
 - 4. Open refrigerant valves except bypass valves that are used for other purposes.
 - 5. Check open compressor-motor alignment and verify lubrication for motors and bearings.
- E. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION 23 23 00

SECTION 23 25 13
WATER TREATMENT FOR CLOSED-LOOP HYDRONIC SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00.
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) requirements.

1.03 SUMMARY

- A. Section includes the following water treatment for closed-loop hydronic systems:
 - 1. Manual chemical-feed equipment.
 - 2. Chemicals.

1.04 ACTION SUBMITTALS

- A. Product Data: Include rated capacities, operating characteristics, and furnished specialties and accessories for the following products:
 - 1. Bypass feeders.
 - 2. Chemical material safety data sheets.
- B. Shop Drawings: Pretreatment and chemical treatment equipment showing tanks, maintenance space required, and piping connections to hydronic systems.
 - 1. Include plans, elevations, sections, and attachment details.
 - 2. Include diagrams for power, signal, and control wiring.

1.05 INFORMATIONAL SUBMITTALS

- A. Water Analysis Provider Qualifications: Verification of experience and capability of HVAC water-treatment service provider.
- B. Field quality-control reports.
- C. Other Informational Submittals:
 - 1. Water Analysis: Illustrate water quality available at Project site.

1.06 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For sensors, injection pumps, and controllers to include in emergency, operation, and maintenance manuals.

1.07 QUALITY ASSURANCE

- A. HVAC Water-Treatment Service Provider Qualifications: An experienced HVAC water-treatment service provider capable of analyzing water qualities, installing water-treatment equipment, and applying water treatment as specified in this Section.

1.08 MAINTENANCE SERVICE

- A. Scope of Maintenance Service: Provide chemicals and service program to maintain water conditions required above to inhibit corrosion and scale formation for hydronic piping and equipment. Services and chemicals shall be provided for a period of one year from date of Substantial Completion and shall include the following:
 - 1. Initial water analysis and HVAC water-treatment recommendations.
 - 2. Startup assistance for Contractor to flush the systems, clean with detergents, and initially fill systems with required chemical treatment prior to operation.
 - 3. Periodic field service and consultation.
 - 4. Customer report charts and log sheets.
 - 5. Laboratory technical analysis.
 - 6. Analyses and reports of all chemical items concerning safety and compliance with government regulations.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Water quality for hydronic systems shall minimize corrosion, scale buildup, and biological growth for optimum efficiency of hydronic equipment without creating a hazard to operating personnel or the environment.
- B. Base HVAC water treatment on quality of water available at Project site, hydronic system equipment material characteristics and functional performance characteristics, operating personnel capabilities, and requirements and guidelines of authorities having jurisdiction.
- C. Closed hydronic systems, including chilled water, shall have the following water qualities:
 - 1. pH: Maintain a value within 9.0 to 10.5.
 - 2. "P" Alkalinity: Maintain a value within 100 to 500 ppm.
 - 3. Boron: Maintain a value within 100 to 200 ppm.
 - 4. Soluble Copper: Maintain a maximum value of .20 ppm.

5. TSS: Maintain a maximum value of 10 ppm.
6. Ammonia: Maintain a maximum value of 20 ppm.
7. Free Caustic Alkalinity: Maintain a maximum value of 20 ppm.
8. Microbiological Limits:
 - a. Total Aerobic Plate Count: Maintain a maximum value of 1000 organisms/mL.
 - b. Total Anaerobic Plate Count: Maintain a maximum value of 100 organisms/mL.
 - c. Nitrate Reducers: Maintain a maximum value of 100 organisms/mL.
 - d. Sulfate Reducers: Maintain a maximum value of zero organisms/mL.
 - e. Iron Bacteria: Maintain a maximum value of zero organisms/mL.

2.02 MANUAL CHEMICAL-FEED EQUIPMENT

- A. Bypass Feeders: Steel, with corrosion-resistant exterior coating, minimum 3-1/2-inch fill opening in the top, and NPS 3/4 bottom inlet and top side outlet. Quarter turn or threaded fill cap with gasket seal and diaphragm to lock the top on the feeder when exposed to system pressure in the vessel.
 1. Refer to the schedule on the drawings.

2.03 CHEMICALS

- A. Chemicals shall be as recommended by water-treatment system manufacturer that are compatible with piping system components and connected equipment and that can attain water quality specified in "Performance Requirements" Article.

PART 3 - EXECUTION

3.01 WATER ANALYSIS

- A. Perform an analysis of supply water to determine quality of water available at Project site.

3.02 INSTALLATION

- A. Install chemical application equipment on concrete bases, level and plumb. Maintain manufacturer's recommended clearances. Arrange units so controls and devices that require servicing are accessible. Anchor chemical tanks and floor-mounting accessories to substrate.
- B. Install water testing equipment on wall near water chemical application equipment.
- C. Bypass Feeders: Install in closed hydronic systems, including chilled water, and equipped with the following:

1. Install bypass feeder in a bypass circuit around circulating pumps unless otherwise indicated on Drawings.
2. Install test-coupon assembly in bypass circuit around circulating pumps unless otherwise indicated on Drawings.
3. Install a gate or full-port ball isolation valves on inlet, outlet, and drain below the feeder inlet.
4. Install a swing check on the inlet after the isolation valve.

3.03 CONNECTIONS

- A. Where installing piping adjacent to equipment, allow space for service and maintenance.
- B. Make piping connections between HVAC water-treatment equipment and dissimilar-metal piping with dielectric fittings. Comply with requirements in Section 232116 “Hydronic Piping Specialties.”
- C. Install shutoff valves on HVAC water-treatment equipment inlet and outlet. Metal general-duty valves are specified in Section 23 05 23.11 “Globe Valves for HVAC Piping,” Section 23 05 23.12 “Ball Valves for HVAC Piping,” Section 23 05 23.13 “Butterfly Valves for HVAC Piping,” and Section 23 05 23.15 “Gate Valves for HVAC Piping.”
- D. Comply with requirements in Section 22 11 19 “Domestic Water Piping Specialties” for backflow preventers required in makeup-water connections to potable-water systems.

3.04 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 1. Inspect field-assembled components and equipment installation, including piping and electrical connections.
 2. Inspect piping and equipment to determine that systems and equipment have been cleaned, flushed, and filled with water, and are fully operational before introducing chemicals for water-treatment system.
 3. Place HVAC water-treatment system into operation and calibrate controls during the preliminary phase of hydronic systems' startup procedures.
 4. Do not enclose, cover, or put piping into operation until it is tested and satisfactory test results are achieved.
 5. Test for leaks and defects. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 6. Leave uncovered and unconcealed new, altered, extended, and replaced water piping until it has been tested and approved. Expose work that has been covered or concealed before it has been tested and approved.
 7. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source

and allow test pressure to stand for four hours. Leaks and loss in test pressure constitute defects.

8. Repair leaks and defects with new materials and retest piping until no leaks exist.
- B. Equipment will be considered defective if it does not pass tests and inspections.
 - C. Prepare test and inspection reports.
 - D. Comply with ASTM D 3370 and with the following standards:
 1. Silica: ASTM D 859.
 2. Acidity and Alkalinity: ASTM D 1067.
 3. Iron: ASTM D 1068.
 4. Water Hardness: ASTM D 1126.

3.05 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain HVAC water-treatment systems and equipment.
- B. Training: Provide a “how-to-use” self-contained breathing apparatus video that details exact operating procedures of equipment.

END OF SECTION 23 25 13

SECTION 23 29 23
VARIABLE FREQUENCY DRIVE UNITS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00.
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) requirements.

1.03 SCOPE

- A. The work, apparatus and materials which shall be furnished under these specifications and accompanying drawings shall include all items specified hereinafter and shown on the drawings. All other materials necessary for the complete installation shall be furnished and installed by the Contractor to provide complete systems as indicated on the drawings and as specified herein.
- B. Coordinate all required interlocks with Division 26. Drives shall contain the necessary auxiliary contacts and control coil voltage to interface with the HVAC temperature control system and fire alarm control system.

1.04 DESCRIPTION OF WORK

- A. Extent of motor controller work is indicated by drawings and schedules. Types of motor controllers specified in this section include the following:
 - 1. Variable Frequency Drives.

1.05 QUALITY ASSURANCE

- A. Installer's Qualifications: Firm with at least 3 years of successful installation experience on B
- B. Codes and Standards:
 - 1. NEMA Compliance: Comply with applicable requirements of NEMA Standards Publications pertaining to motor controllers.
 - 2. UL Compliance and Labeling: Comply with applicable requirements of UL safety standards pertaining to motor controllers. Provide motor controllers and components which have been UL-listed and labeled.
 - 3. NEC Compliance: Comply with applicable requirements of NEC pertaining to construction and installation of motor controllers.

1.06 SUBMITTALS

A. Product Data:

1. Submit manufacturer's performance data including dimensional drawings, power circuit diagrams, installation and maintenance manuals, warranty description, VFD's FLA rating, certification agency file numbers and catalog information.
2. The specification lists the minimum VFD performance requirements for this project. Each supplier shall list any exceptions to the specification. If no departures from the specification are identified, the supplier shall be bound by the specification.
3. Submit a Harmonic Distortion Analysis for the jobsite location.

1.07 MANUFACTURERS

A. Manufacturer: Subject to compliance with requirements, provide Variable Frequency Drives of one of the following or approved equivalent:

1. Allen Bradley
2. Danfoss
3. Trane

PART 2 - PRODUCTS

2.01 VARIABLE FREQUENCY DRIVE

- A. Furnish complete variable frequency drives as specified herein for the fans and pumps designated on the drawing schedules to be variable speed. All standard and optional features shall be included within the VFD enclosure, unless otherwise specified. VFD shall be housed in a metal NEMA 12 enclosure, or other NEMA Type according to the installation and operating conditions at the job site.
- B. The VFD shall convert incoming fixed frequency three-phase AC power into a variable frequency and voltage for controlling the speed of three-phase AC motors. The motor current shall closely approximate a sine wave. Motor voltage shall be varied with frequency to maintain desired motor magnetization current suitable for centrifugal pump and fan control and to negate the need for motor derating.
- C. An advanced sine wave approximation and voltage vector control shall be used to allow operation at rated motor shaft output at nominal speed with no derating. This voltage vector control shall minimize harmonics to the motor to increase motor efficiency and life.
- D. The VFD shall include a full-wave diode bridge rectifier and maintain a fundamental power factor near unity regardless of speed or load.
- E. The VFD and options shall be tested to ANSI/UL Standard 508. The complete VFD, including all specified options, shall be assembled by the manufacturer, which shall be UL-508 certified for the building and assembly of option panels. Local representative panel shop assembly for option panels is not acceptable. The appropriate UL stickers shall be applied to both the drive and option panel, in the case where these are not contained in one panel.

- F. The VFD shall have dual DC link reactors to minimize power line harmonics. If DC link reactors are not provided VFD shall be provided with a 5% impedance line reactor and isolation transformer.
- G. The VFD's full load amp rating shall meet or exceed NEC Table 430-250. The VFD shall be able to provide full rated output current continuously, 110% of rated current for 60 seconds and 160% of rated current for up to 0.5 second while starting.
- H. The VFD shall be able to provide full torque at any selected speed up to base speed to allow driving direct drive fans without derating.
- I. An automatic energy optimization selection feature shall be provided standard in the drive. This feature shall automatically and continually monitor the motor's speed and load and adjust the applied voltage to maximize energy savings and provide a 3% to 10% additional energy savings.
- J. Input and output power circuit switching can be done without interlocks or damage to the VFD.
- K. An automatic motor adaptation test algorithm shall measure motor stator resistance and reactance to optimize performance and efficiency. It shall not be necessary to run the motor or decouple the motor from the load to run the test.
- L. Protective Features
 - 1. Class 20 I2t electronic motor overload protection for single motor applications and thermal-mechanical overloads for multiple motor applications.
 - 2. Protection against input transients, loss of AC line phase, short circuit, ground fault, overvoltage, undervoltage, drive overtemperature and motor overtemperature. The VFD shall display all faults in plain English. Codes are not acceptable.
 - 3. Protect VFD from sustained power or phase loss. The VFD shall provide full rated output with an input voltage as low as 90% of the nominal. The VFD will continue to operate with reduced output with an input voltage as low as 150 volts for 208/230 volt units, and 285 volts for 460 volt units.
 - 4. The VFD shall incorporate a motor preheat circuit to keep the motor warm and prevent condensation build up in the stator.
 - 5. Drive shall have semi-conductor rated input fuses to protect power components.
 - 6. To prevent breakdown of the motor winding insulation, the dV/dt must be below 1500 V/msec per IEC recommendations. The supplier shall include with the quotation the dV/dt values of the drive.
 - 7. Drive shall include a "signal loss detection" circuit to sense the loss of the control signal, and shall be programmable to react as desired in such instance.
 - 8. Drive shall be designed and constructed so that input or outputs can be disconnected with the drive running without the need for interlocks.
 - 9. Drive shall catch a rotating motor operating forward or reverse up to full speed.
 - 10. VFD shall be rated for 100,000 amp interrupting capacity (AIC).

11. Drive shall include current sensors on all three output phases to detect and report phase loss to the motor. The VFD will identify which of the output phases is low or lost.
12. Drive shall continue to operate without faulting until input voltage exceeds 300 volts on 208/230 volt drives, and 604 volts on 460 volt drives.
13. Provide drive input and main fusing.

M. Interface Features

1. Hand/Start, Off/Stop and Auto/Start selector switches shall be provided to start and stop the drive and determine the speed reference.
2. Provide a 24 V DC output signal to indicate that the drive is in Auto/Remote mode.
3. Digital manual speed control. Potentiometers are not acceptable.
4. Lockable, alphanumeric backlit display keypad can be remotely mounted up to 10 feet away using standard 9-pin cable.
5. All keypads shall be identical and interchangeable.
6. Drive may be operated with keypad removed.
7. All HVAC drives shall use the same control keypad.
8. To setup multiple drives, it shall be possible to upload all setup parameters to the drive's keypad, place that keypad on all other drives in turn and download the setup to each drive.
9. Display shall be programmable to display in 9 languages including English, Spanish and French.
10. The display shall have four lines, with 20 characters on three lines and eight large characters on one line.
11. Two lines of the display shall allow free programming so that the exact unit controlled by the drive can be identified.
12. A red FAULT light, a yellow WARNING light and a green POWER-ON light shall be provided. These indications shall be visible both on the keypad and on the drive when the keypad is removed.
13. A quick setup menu with factory preset typical HVAC parameters shall be provided on the drive eliminating the need for macros.
14. The drive shall be fitted with an RS 485 serial communications port and be supplied with Windows® compatible software to display all monitoring, fault, alarm and status signals. The software shall allow parameter changes to be made to the drive settings, as well as storage of each controller's operating and setup parameters, and remote operation of the drive.

15. Two set-point control interface (PID control) shall be standard in the unit. Drive shall be able to look at two feedback signals, compare with two set-points and make various process control decisions.
16. Floating point control interface shall be provided to increase/decrease speed in response to switch closures.
17. Sleep mode shall be provided to automatically stop the drive when speed drops below set "sleep" level for a specified time. Drive automatically restarts when speed command exceeds set "wake" level.
18. Run permissive circuit shall be provided to accept a "system ready" signal to assure that the drive does not start until dampers or other auxiliary equipment are in the proper state for drive operation.
19. An elapsed time meter and kWh meter shall be provided.
20. The following displays shall be accessible from the control panel in actual units: Reference Signal Value in actual units, Output Frequency in Hz or percent, Output Amps, Motor HP, Motor kW, KWH, Output Voltage, No Load Warning, DC Bus Voltage, Drive Temperature in degrees, and Motor Speed in engineering units per application (in percent speed, GPM, CFM,...). Drive will read out the selected engineering unit either in a linear, square or cubed relationship to output frequency as appropriate to the unit chosen.
21. Up to four meter displays can be shown at once on the display. This allows the actual value of the follower signal to be shown simultaneously with the drive's response to that signal for ease in commissioning.
22. Drive will sense the loss of load and signal a no load/broken belt warning or fault.
23. The VFD shall have temperature controlled cooling fans for quiet operation and minimized losses.
24. The VFD shall store in memory the last 20 faults and record all operational data.
25. Eight programmable digital inputs shall be provided for interfacing with the systems control and safety interlock circuitry.
26. Two programmable relay outputs, one Form C 240 V AC, one Form A 50 V AC, shall be provided for remote indication of drive status.
27. Two programmable analog inputs shall be provided and shall accept a direct-or-reverse acting signal. Analog reference inputs accepted shall include 0-10 V dc, 0-20 mA and 4-20 mA.
28. Two programmable analog outputs shall be provided for indication of drive status. These outputs shall be programmable for output speed, voltage, frequency, amps and input kW.
29. Under fire mode conditions the VFD shall automatically default to a preset speed.

N. Adjustments

1. VFD shall have an adjustable carrier frequency.
2. Sixteen preset speeds shall be provided.
3. Four acceleration and four deceleration ramps shall be provided. Accel and decel time shall be adjustable over the range from 0 to 3,600 seconds to base speed. The shape of these curves may be automatically contoured to prevent tripping.
4. Four current limit settings shall be provided.
5. If the VFD trips on one of the following conditions, the VFD shall be programmable for automatic or manual reset: undervoltage, overvoltage, current limit, inverter overload and motor overload.
6. The number of restart attempts shall be selectable from 0 through 20 and the time between attempts shall be adjustable from 0 through 600 seconds.
7. An automatic “on delay” may be selected from 0 to 120 seconds.

O. Bypass

1. Provide a manual bypass consisting of a door interlocked main fused disconnect padlockable in the off position, a built-in motor starter and a four position DRIVE/OFF/LINE/TEST switch controlling three contactors. In the DRIVE position, the motor is operated at an adjustable speed from the drive. In the OFF position, the motor and drive are disconnected. In the LINE position, the motor is operated at full speed from the AC power line and power is disconnected from the drive so that service can be performed. In the TEST position, the motor is operated at full speed from the AC line power. This allows the drive to be given an operational test while continuing to run the motor at full speed in bypass. Customer supplied normally closed dry contact shall be interlocked with the drives safety trip circuitry to stop the motor whether in DRIVE or BYPASS mode in case of an external safety fault.

P. Service Conditions

1. Ambient temperature, -10 to 40°C (14 to 104°F).
2. to 95% relative humidity, non-condensing.
3. Elevation to 3,300 feet without derating.
4. AC line voltage variation, -10 to +10% of nominal with full output.
5. No side clearance shall be required for cooling of any NEMA 1 units, or of any NEMA 12 units of less than 75 HP at 460 volts. All power and control wiring shall be done from the bottom.
6. Provide surge suppression.

Q. Quality Assurance

1. To ensure quality and minimize infantile failures at the jobsite, the complete VFD shall be tested by the manufacturer. The VFD shall operate a dynamometer at full load and the load and speed shall be cycled during the test.

2. All optional features shall be functionally tested at the factory for proper operation.

PART - EXECUTION

3.01 DRIVES AND ASSOCIATED CONTROLS

- A. Unless otherwise indicated, drives shown on the drawings shall be furnished and installed under this section. The full load current and starting characteristics of each motor shall be verified for proper selection of motor over load devices. The Contractor shall furnish and install all steel shapes, etc., necessary for a support of all motor controllers.
- B. Unless otherwise indicated, all control devices, such as thermostats, firestats, etc., shall be installed in place and wired under other sections of the specifications. Coordinate required starter auxiliary contacts and coil voltages for a properly operational system.
- C. Motor controllers shall be installed in accordance with all applicable NEC installation requirements.
- D. Variable Frequency Drive Startup Assistance: The manufacturer shall provide start-up assistance in the form of a factory trained service technician. When factory authorized start-up is performed, the warranty shall be extended to 60 months from date of shipment.

3.02 IDENTIFICATION OF EQUIPMENT

- A. Identification shall be provided for all motor controllers installed by the Contractor. Identification shall consist of white laminated plastic plates with black engraved letters.

END OF SECTION 23 29 23

SECTION 23 31 13
METAL DUCTS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00.
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) requirements.

1.03 SUMMARY

- A. Section Includes:
 - 1. Single-wall rectangular ducts and fittings.
 - 2. Double-wall rectangular ducts and fittings.
 - 3. Single-wall round and flat-oval ducts and fittings.
 - 4. Double-wall round and flat-oval ducts and fittings.
 - 5. Sheet metal materials.
 - 6. Sealants and gaskets.
 - 7. Hangers and supports.
- B. Related Sections:
 - 1. Section 23 05 93 “Testing, Adjusting, and Balancing for HVAC” for testing, adjusting, and balancing requirements for metal ducts.
 - 2. Section 23 33 00 “Air Duct Accessories” for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.04 PERFORMANCE REQUIREMENTS

- A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's “HVAC Duct Construction Standards - Metal and Flexible” and performance requirements and design criteria indicated in “Duct Schedule” Article.
- B. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

1.05 ACTION SUBMITTALS

- A. Product Data: For each type of the following products:
 - 1. Liners and adhesives.
 - 2. Sealants and gaskets.
- B. Shop Drawings:
 - 1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
 - 2. Factory- and shop-fabricated ducts and fittings.
 - 3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
 - 4. Elevation of top of ducts.
 - 5. Dimensions of main duct runs from building grid lines.
 - 6. Fittings.
 - 7. Reinforcement and spacing.
 - 8. Seam and joint construction.
 - 9. Penetrations through fire-rated and other partitions.
 - 10. Equipment installation based on equipment being used on Project.
 - 11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
 - 12. Hangers and supports, including methods for duct and building attachment and vibration isolation.

1.06 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
 - 2. Suspended ceiling components.
 - 3. Structural members to which duct will be attached.
 - 4. Size and location of initial access modules for acoustical tile.
 - 5. Penetrations of smoke barriers and fire-rated construction.

6. Items penetrating finished ceiling including the following:
 - a. Lighting fixtures.
 - b. Air outlets and inlets.
 - c. Speakers.
 - d. Sprinklers.
 - e. Access panels.
 - f. Perimeter moldings.

B. Field quality-control reports.

1.07 QUALITY ASSURANCE

- A. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-up."
- B. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

PART 2 - PRODUCTS

2.01 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.
- B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.02 DOUBLE-WALL RECTANGULAR DUCTS AND FITTINGS

- A. Rectangular Ducts: Fabricate ducts with indicated dimensions for the inner duct.

- B. Outer Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.
- C. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- D. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- E. Interstitial Insulation: Fibrous-glass liner complying with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
 - 1. Maximum Thermal Conductivity: 0.27 Btu x in./h x sq. ft. x°F at 75°F mean temperature.
 - 2. Install spacers that position the inner duct at uniform distance from outer duct without compressing insulation.
 - 3. Coat insulation with antimicrobial coating.
 - 4. Cover insulation with polyester film complying with UL 181, Class 1.
- F. Interstitial Insulation: Flexible elastomeric duct liner complying with ASTM C 534, Type II for sheet materials, and with NFPA 90A or NFPA 90B.
 - 1. Maximum Thermal Conductivity: 0.25 Btu x in./h x sq. ft. x°F at 75°F mean temperature.
- G. Inner Duct: Minimum solid sheet steel.
- H. Formed-on Transverse Joints (Flanges): Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- I. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.03 SINGLE-WALL ROUND AND FLAT-OVAL DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.

- B. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension).
- C. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 - 1. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.
- D. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 - 1. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.
 - 2. Fabricate flat-oval ducts larger than 72 inches in width (major dimension) with butt-welded longitudinal seams.
- E. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.04 DOUBLE-WALL ROUND AND FLAT-OVAL DUCTS AND FITTINGS

- A. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension) of the inner duct.
- B. Outer Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on static-pressure class unless otherwise indicated.
 - 1. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 - a. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.
 - 2. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

- a. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.
 - b. Fabricate flat-oval ducts larger than 72 inches in width (major dimension) with butt-welded longitudinal seams.
- 3. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- C. Inner Duct: Minimum solid sheet steel.
- D. Interstitial Insulation: Fibrous-glass liner complying with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
 - 1. Maximum Thermal Conductivity: 0.27 Btu x in./h x sq. ft. x°F at 75°F mean temperature.
 - 2. Install spacers that position the inner duct at uniform distance from outer duct without compressing insulation.
 - 3. Coat insulation with antimicrobial coating.
 - 4. Cover insulation with polyester film complying with UL 181, Class 1.
- E. Interstitial Insulation: Flexible elastomeric duct liner complying with ASTM C 534, Type II for sheet materials, and with NFPA 90A or NFPA 90B.
 - 1. Maximum Thermal Conductivity: 0.25 Btu x in./h x sq. ft. x°F at 75°F mean temperature.

2.05 SHEET METAL MATERIALS

- A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
 - 1. Galvanized Coating Designation: G60.
 - 2. Finishes for Surfaces Exposed to View: Mill phosphatized.
- C. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304 or 316, as indicated in the "Duct Schedule" Article; cold rolled, annealed, sheet. Exposed surface finish shall be No. 2B, No. 2D, No. 3, or No. 4 as indicated in the "Duct Schedule" Article.
- D. Factory- or Shop-Applied Antimicrobial Coating:

1. Apply to the surface of sheet metal that will form the interior surface of the duct. An untreated clear coating shall be applied to the exterior surface.
 2. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
 3. Coating containing the antimicrobial compound shall have a hardness of 2H, minimum, when tested according to ASTM D 3363.
 4. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
 5. Shop-Applied Coating Color: Black.
 6. Antimicrobial coating on sheet metal is not required for duct containing liner treated with antimicrobial coating.
- E. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.
- F. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.06 SEALANT AND GASKETS

- A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
- B. Two-Part Tape Sealing System:
1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
 2. Tape Width: 3 inches.
 3. Sealant: Modified styrene acrylic.
 4. Water resistant.
 5. Mold and mildew resistant.
 6. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
 7. Service: Indoor and outdoor.
 8. Service Temperature: Minus 40 to plus 200°F.

9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.
 10. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- C. Water-Based Joint and Seam Sealant:
1. Application Method: Brush on.
 2. Solids Content: Minimum 65 percent.
 3. Shore A Hardness: Minimum 20.
 4. Water resistant.
 5. Mold and mildew resistant.
 6. VOC: Maximum 75 g/L (less water).
 7. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
 8. Service: Indoor or outdoor.
 9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.
- D. Flanged Joint Sealant: Comply with ASTM C 920.
1. General: Single-component, acid-curing, silicone, elastomeric.
 2. Type: S.
 3. Grade: NS.
 4. Class: 25.
 5. Use: O.
 6. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- E. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.
- F. Round Duct Joint O-Ring Seals:
1. Seal shall provide maximum 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for 10-inch wg static-pressure class, positive or negative.
 2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
 3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.07 HANGERS AND SUPPORTS

- A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.
- B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
- C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."
- D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.
- E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.
- F. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.
- G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- H. Trapeze and Riser Supports:
 - 1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
 - 2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
 - 3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

PART 3 - EXECUTION

3.01 DUCT INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.
- B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.
- C. Install round and flat-oval ducts in maximum practical lengths.
- D. Install ducts with fewest possible joints.
- E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.
- F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

- G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.
- I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.
- J. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.
- K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Section 233300 "Air Duct Accessories" for fire and smoke dampers.
- L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."

3.02 INSTALLATION OF EXPOSED DUCTWORK

- A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.
- B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.
- C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.
- D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.
- E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.03 ADDITIONAL INSTALLATION REQUIREMENTS FOR COMMERCIAL KITCHEN HOOD EXHAUST DUCT

- A. Install commercial kitchen hood exhaust ducts without dips and traps that may hold grease, and sloped a minimum of 2 percent to drain grease back to the hood.
- B. Install fire-rated access panel assemblies at each change in direction and at maximum intervals of 20 feet in horizontal ducts, and at every floor for vertical ducts, or as indicated on Drawings.
- C. Do not penetrate fire-rated assemblies except as allowed by applicable building codes and authorities having jurisdiction.

3.04 DUCT SEALING

- A. Seal ducts to Seal Class C according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":

3.05 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."
- B. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.
- C. Hangers Exposed to View: Threaded rod and angle or channel supports.
- D. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum interval of 16 feet.
- E. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.06 CONNECTIONS

- A. Make connections to equipment with flexible connectors complying with Section 233300 "Air Duct Accessories."
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.07 PAINTING

- A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Section 09 91 13 "Exterior Painting" and Section 09 91 23 "Interior Painting."

3.08 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Leakage Tests:
 - 1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.
 - 2. Test the following systems:

- a. Ducts with a Pressure Class Higher Than 3-Inch wg: Test representative duct sections totaling no less than 25 percent of total installed duct area for each designated pressure class.
 - b. Supply Ducts with a Pressure Class of 2-Inch wg or Higher: Test representative duct sections totaling no less than 50 percent of total installed duct area for each designated pressure class.
 - c. Return Ducts with a Pressure Class of 2-Inch wg or Higher: Test representative duct sections totaling no less than 50 percent of total installed duct area for each designated pressure class.
 - d. Exhaust Ducts with a Pressure Class of 2-Inch wg or Higher: Test representative duct sections totaling no less than 50 percent of total installed duct area for each designated pressure class.
 - e. Outdoor Air Ducts with a Pressure Class of 2-Inch wg or Higher: Test representative duct sections totaling no less than 50 percent of total installed duct area for each designated pressure class.
- 3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
 - 4. Test for leaks before applying external insulation.
 - 5. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.
 - 6. Give seven days' advance notice for testing.
- C. Duct System Cleanliness Tests:
- 1. Visually inspect duct system to ensure that no visible contaminants are present.
 - 2. Test sections of metal duct system, chosen randomly by Owner, for cleanliness according to "Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."
 - a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.
- D. Duct system will be considered defective if it does not pass tests and inspections.
 - E. Prepare test and inspection reports.

3.09 DUCT CLEANING

- A. Clean duct system(s) before testing, adjusting, and balancing.
- B. Use service openings for entry and inspection.

1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Section 23 33 00 "Air Duct Accessories" for access panels and doors.
 2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
 3. Remove and reinstall ceiling to gain access during the cleaning process.
- C. Particulate Collection and Odor Control:
1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
 2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.
- D. Clean the following components by removing surface contaminants and deposits:
1. Air outlets and inlets (registers, grilles, and diffusers).
 2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
 3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
 4. Coils and related components.
 5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
 6. Supply-air ducts, dampers, actuators, and turning vanes.
 7. Dedicated exhaust and ventilation components and makeup air systems.
- E. Mechanical Cleaning Methodology:
1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
 2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
 3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
 4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.

5. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
6. Provide drainage and cleanup for wash-down procedures.
7. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to manufacturer's written instructions after removal of surface deposits and debris.

3.10 START UP

- A. Air Balance: Comply with requirements in Section 23 05 93 "Testing, Adjusting, and Balancing for HVAC."

3.11 DUCT SCHEDULE

A. Supply Ducts:

1. Ducts Connected to Fan Coil Units and Terminal Units:
 - a. Pressure Class: Positive 2-inch wg.
2. Ducts Connected to Constant-Volume Air-Handling Units:
 - a. Pressure Class: Positive 3-inch wg.
3. Ducts Connected to Variable-Air-Volume Air-Handling Units:
 - a. Pressure Class: Positive 3-inch wg.
4. Ducts Connected to Equipment Not Listed Above:
 - a. Pressure Class: Positive 3-inch wg.

B. Return Ducts:

1. Ducts Connected to Fan Coil Units and Terminal Units:
 - a. Pressure Class: Positive or negative 1-inch wg.
2. Ducts Connected to Air-Handling Units:
 - a. Pressure Class: Positive or negative 2-inch wg.
3. Ducts Connected to Equipment Not Listed Above:
 - a. Pressure Class: Positive or negative 2-inch wg.

C. Exhaust Ducts:

1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:
 - a. Pressure Class: Negative 1-inch wg.

2. Ducts Connected to Air-Handling Units:
 - a. Pressure Class: Positive or negative 2-inch wg.
 3. Ducts Connected to Commercial Kitchen Hoods: Comply with NFPA 96.
 - a. Exposed to View: Type 304, stainless-steel sheet, No. 4 finish.
 - b. Concealed: Type 304, stainless-steel sheet, No. 2D finish.
 - c. Welded seams and joints.
 - d. Pressure Class: Positive or negative 2-inch wg.
 - e. Minimum SMACNA Seal Class: Welded seams, joints, and penetrations.
 - f. SMACNA Leakage Class: 3.
 4. Ducts Connected to Equipment Not Listed Above:
 - a. Pressure Class: Positive or negative 2-inch wg.
- D. Intermediate Reinforcement:
1. Galvanized-Steel Ducts: Galvanized steel.
 2. Stainless-Steel Ducts:
 - a. Exposed to Airstream: Match duct material.
 - b. Not Exposed to Airstream: Match duct material.
- E. Double-Wall Duct Interstitial Insulation:
1. Supply Air Ducts: 2 inches thick.
 2. Return Air Ducts: 1-1/2 inches thick.
 3. Exhaust Air Ducts: 1 inch thick.
- F. Elbow Configuration:
1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."
 - a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
 - b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
 - c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

2. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows."
 - a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.
 - 1) Radius-to Diameter Ratio: 1.5.
 - b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
 - c. Round Elbows, 14 Inches and Larger in Diameter: Standing seam.

G. Branch Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."
 - a. Rectangular Main to Rectangular Branch: 45-degree entry.
 - b. Rectangular Main to Round Branch: Spin in.
2. Round and Flat Oval: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.
 - a. Velocity 1000 fpm or Lower: 90-degree tap.
 - b. Velocity 1000 to 1500 fpm: Conical tap.
 - c. Velocity 1500 fpm or Higher: 45-degree lateral.

END OF SECTION 23 31 13

SECTION 23 33 00
AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00.
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) requirements.

1.03 SUMMARY

- A. Section Includes:
 - 1. Backdraft and pressure relief dampers.
 - 2. Manual volume dampers.
 - 3. Control dampers.
 - 4. Fire dampers.
 - 5. Flange connectors.
 - 6. Turning vanes.
 - 7. Remote damper operators.
 - 8. Duct-mounted access doors.
 - 9. Flexible connectors.
 - 10. Flexible ducts.
 - 11. Duct accessory hardware.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. For duct silencers, include pressure drop and dynamic insertion loss data. Include breakout noise calculations for high transmission loss casings.
- B. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.

1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:
 - a. Special fittings.
 - b. Manual volume damper installations.
 - c. Control-damper installations.
 - d. Fire-damper, smoke-damper, combination fire- and smoke-damper, ceiling, and corridor damper installations, including sleeves; and duct-mounted access doors and remote damper operators.
 - e. Duct security bars.
 - f. Wiring Diagrams: For power, signal, and control wiring.

1.05 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

1.06 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Fusible Links: Furnish quantity equal to 10 percent of amount installed.

PART 2 - PRODUCTS

2.01 ASSEMBLY DESCRIPTION

- A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

2.02 MATERIALS

- A. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
 1. Galvanized Coating Designation: G60.
 2. Exposed-Surface Finish: Mill phosphatized.
- B. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304, and having a No. 2 finish for concealed ducts and finish for exposed ducts.

- C. Aluminum Sheets: Comply with ASTM B 209, Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.
- D. Extruded Aluminum: Comply with ASTM B 221, Alloy 6063, Temper T6.
- E. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.
- F. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.03 BACKDRAFT AND PRESSURE RELIEF DAMPERS

- A. Description: Gravity balanced.
- B. Maximum Air Velocity: 3000 fpm.
- C. Maximum System Pressure: 3-inch wg.
- D. Frame: Hat-shaped, 0.094-inch- thick, galvanized sheet steel or 0.03-inch- thick stainless steel, with welded corners or mechanically attached and mounting flange.
- E. Blades: Multiple single-piece blades, center pivoted, maximum 6-inch width, 0.025-inch-thick, roll-formed aluminum with sealed edges.
- F. Blade Action: Parallel.
- G. Blade Seals: Neoprene, mechanically locked.
- H. Blade Axles:
 - 1. Material: Aluminum.
 - 2. Diameter: 0.20 inch.
- I. Tie Bars and Brackets: Aluminum.
- J. Return Spring: Adjustable tension.
- K. Bearings: Steel ball or synthetic pivot bushings.
- L. Accessories: Refer to drawings.

2.04 MANUAL VOLUME DAMPERS

- A. Standard, Steel, Manual Volume Dampers:
 - 1. Suitable for horizontal or vertical applications.
 - 2. Frames:
 - a. Frame: Hat-shaped, 0.094-inch- thick, galvanized sheet steel.
 - b. Mitered and welded corners.

- c. Flanges for attaching to walls and flangeless frames for installing in ducts.
 - 3. Blades:
 - a. Multiple or single blade.
 - b. Parallel- or opposed-blade design.
 - c. Stiffen damper blades for stability.
 - d. Galvanized steel, 0.064 inch thick.
 - 4. Blade Axles: Galvanized steel.
 - 5. Bearings:
 - a. Oil-impregnated stainless-steel sleeve.
 - b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
 - 6. Tie Bars and Brackets: Galvanized steel.
- B. Standard, Aluminum, Manual Volume Dampers:
- 1. Standard leakage rating, with linkage outside airstream.
 - 2. Suitable for horizontal or vertical applications.
 - 3. Frames: Hat-shaped, 0.10-inch- thick, aluminum sheet channels; frames with flanges for attaching to walls and flangeless frames for installing in ducts.
 - 4. Blades:
 - a. Multiple or single blade.
 - b. Parallel- or opposed-blade design.
 - c. Stiffen damper blades for stability.
 - d. Roll-Formed Aluminum Blades: 0.10-inch- thick aluminum sheet.
 - e. Extruded-Aluminum Blades: 0.050-inch- thick extruded aluminum.
 - 5. Blade Axles: Galvanized steel.
 - 6. Bearings:
 - a. Stainless-steel sleeve.
 - b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.

7. Tie Bars and Brackets: Aluminum.
- C. Jackshaft:
1. Size: 0.5-inch diameter.
 2. Material: Galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
 3. Length and Number of Mountings: As required to connect linkage of each damper in multiple-damper assembly.
- D. Damper Hardware:
1. Zinc-plated, die-cast core with dial and handle made of 3/32-inch- thick zinc-plated steel, and a 3/4-inch hexagon locking nut.
 2. Include center hole to suit damper operating-rod size.
 3. Include elevated platform for insulated duct mounting.

2.05 FIRE DAMPERS

- A. Type: Dynamic; rated and labeled according to UL 555 by an NRTL.
- B. Closing rating in ducts up to 4-inch wg static pressure class and minimum 4000-fpm velocity.
- C. Fire Rating: 1-1/2 hours.
- D. Frame: Curtain type with blades outside airstream except when located behind grille where blades may be inside airstream; fabricated with roll-formed, 0.034-inch- thick galvanized steel; with mitered and interlocking corners.
- E. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.
 1. Minimum Thickness: 0.39 inch thick, as indicated, and of length to suit application.
 2. Exception: Omit sleeve where damper-frame width permits direct attachment of perimeter mounting angles on each side of wall or floor; thickness of damper frame must comply with sleeve requirements.
- F. Mounting Orientation: Vertical or horizontal as indicated.
- G. Blades: Roll-formed, interlocking, 0.034-inch-thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- thick, galvanized-steel blade connectors.
- H. Heat-Responsive Device: Replaceable, 165°F rated, fusible links.

2.06 TURNING VANES

- A. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
 - 1. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.
- B. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 4-3, "Vaness and Vane Runners," and 4-4, "Vane Support in Elbows."
- C. Vane Construction: Single wall for ducts up to 24 inches wide and double wall for larger dimensions.

2.07 REMOTE DAMPER OPERATORS

- A. Description: Cable system designed for remote manual damper adjustment.
- B. Tubing: Brass.
- C. Cable: Stainless steel.
- D. Wall-Box Mounting: Recessed
- E. Wall-Box Cover-Plate Material: Stainless steel.

2.08 DUCT-MOUNTED ACCESS DOORS

- A. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 7-2, "Duct Access Doors and Panels," and 7-3, "Access Doors - Round Duct."
 - 1. Door:
 - a. Double wall, rectangular.
 - b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
 - c. Vision panel.
 - d. Hinges and Latches: 1-by-1-inchbutt or piano hinge and cam latches.
 - e. Fabricate doors airtight and suitable for duct pressure class.
 - 2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
- B. Pressure Relief Access Door:
 - 1. Door and Frame Material: Galvanized sheet steel.
 - 2. Door: Double wall with insulation fill with metal thickness applicable for duct pressure class.

3. Operation: Open outward for positive-pressure ducts and inward for negative-pressure ducts.
4. Doors close when pressures are within set-point range.

2.09 FLEXIBLE CONNECTORS

- A. Materials: Flame-retardant or noncombustible fabrics.
- B. Coatings and Adhesives: Comply with UL 181, Class 1.
- C. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches wide attached to two strips of 2-3/4-inch- wide, 0.028-inch- thick, galvanized sheet steel or 0.032-inch-thick aluminum sheets. Provide metal compatible with connected ducts.
- D. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
 1. Minimum Weight: 26 oz./sq. yd..
 2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
 3. Service Temperature: Minus 40 to plus 200°F.
- E. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.
 1. Minimum Weight: 24 oz./sq. yd..
 2. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.
 3. Service Temperature: Minus 50 to plus 250°F.

2.10 FLEXIBLE DUCTS

- A. Insulated, Flexible Duct: UL 181, Class 1, aluminum laminate and polyester film with latex adhesive supported by helically wound, spring-steel wire; fibrous-glass insulation; aluminized vapor-barrier film.
 1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
 2. Maximum Air Velocity: 4000 fpm.
 3. Temperature Range: Minus 20 to plus 210°F.
 4. Insulation R-value: Comply with ASHRAE/IESNA 90.1.
- B. Flexible Duct Connectors:
 1. Clamps: Nylon strap in sizes 3 through 18 inches, to suit duct size.

2.11 DUCT ACCESSORY HARDWARE

- A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.

- B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.
- B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.
- C. Install dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.
- D. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
 - 1. Install steel volume dampers in steel ducts.
 - 2. Install aluminum volume dampers in aluminum ducts.
- E. Set dampers to fully open position before testing, adjusting, and balancing.
- F. Install test holes at fan inlets and outlets and elsewhere as indicated.
- G. Install fire dampers according to UL listing.
- H. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
 - 1. At outdoor-air intakes and mixed-air plenums.
 - 2. At drain pans and seals.
 - 3. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
 - 4. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
 - 5. At each change in direction and at maximum 50-foot spacing.
 - 6. Upstream from turning vanes.
 - 7. Upstream or downstream from duct silencers.

8. Control devices requiring inspection.
9. Elsewhere as indicated.
- I. Install access doors with swing against duct static pressure.
- J. Access Door Sizes:
 1. One-Hand or Inspection Access: 8 by 5 inches.
 2. Two-Hand Access: 12 by 6 inches.
 3. Head and Hand Access: 18 by 10 inches.
 4. Head and Shoulders Access: 21 by 14 inches.
 5. Body Access: 25 by 14 inches.
 6. Body plus Ladder Access: 25 by 17 inches.
- K. Label access doors according to Section 23 05 53 "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.
- L. Install flexible connectors to connect ducts to equipment.
- M. For fans developing static pressures of 5-inch wg and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.
- N. Connect flexible ducts to metal ducts with adhesive plus sheet metal screws.
- O. Install duct test holes where required for testing and balancing purposes.

3.02 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 1. Operate dampers to verify full range of movement.
 2. Inspect locations of access doors and verify that purpose of access door can be performed.
 3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
 4. Inspect turning vanes for proper and secure installation.

END OF SECTION 23 33 00

SECTION 23 36 16
VARIABLE AIR-VOLUME UNITS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00.
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) requirements.

1.03 SUMMARY

- A. Section Includes:
 - 1. Shutoff, single-duct air terminal units.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of air terminal unit.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for air terminal units.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For air terminal units.
 - 1. Include plans, elevations, sections, and mounting details.
 - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Include diagrams for power, signal, and control wiring.
 - 4. Hangers and supports, including methods for duct and building attachment and vibration isolation.

1.05 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For air terminal units to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 01 78 23 “Operation and Maintenance Data,” include the following:
 - a. Instructions for resetting minimum and maximum air volumes.
 - b. Instructions for adjusting software set points.

PART 2 - PRODUCTS

2.01 SYSTEM DESCRIPTION

- A. 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.
- B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - “Systems and Equipment” and Section 7 - “Construction and System Start-up.”
- C. ASHRAE Compliance: Applicable requirements in ASHRAE/IES 90.1, “Section 6 - Heating, Ventilating, and Air Conditioning.”

2.02 SHUTOFF, SINGLE-DUCT AIR TERMINAL UNITS

- A. Configuration: Volume-damper assembly inside unit casing with control components inside a protective metal shroud.
- B. Casing: 0.034-inch-thick galvanized steel, single wall.
 1. Casing Liner: Comply with requirements in “Casing Liner” Article for fibrous-glass duct liner.
 2. Air Inlet: Round stub connection or S-slip and drive connections for duct attachment.
 3. Air Outlet: S-slip and drive connections.
 4. Access: Removable panels for access to parts requiring service, adjustment, or maintenance; with airtight gasket.
 5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- C. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.
 1. Maximum Damper Leakage: AHRI 880 rated, 2 percent of nominal airflow at 3-inch wg inlet static pressure.
 2. Damper Position: Normally open.
- D. Electric-Resistance Heating Coils: Nickel-chromium heating wire, free of expansion noise and hum, mounted in ceramic inserts in a galvanized-steel housing; with primary automatic, and secondary manual, reset thermal cutouts. Terminate elements in stainless-steel, machine-staked terminals secured with stainless-steel hardware.
 1. Stage(s): as scheduled in the drawings.

2. Access door interlocked disconnect switch.
 3. Downstream air temperature sensor with local connection to override discharge-air temperature to not exceed a maximum temperature set point (adjustable).
 4. Nickel chrome 80/20 heating elements.
 5. Airflow switch for proof of airflow.
 6. Fuses in terminal box for overcurrent protection (for coils more than 48 A).
 7. Mercury contactors.
 8. Magnetic contactor for each step of control (for three-phase coils).
- E. Controls:
1. Suitable for operation with duct pressures between 0.25- and 3.0-inch wg inlet static pressure.
 2. System-powered, wall-mounted thermostat.
- F. Control Sequences:
1. Refer to the controls sequences shown in the drawings.
- G. Casing Liner: Fibrous-glass duct liner, complying with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
1. Minimum Thickness: 1 inch.
 - a. Maximum Thermal Conductivity:
 2. Antimicrobial Erosion-Resistant Coating: Apply to the surface of the liner that will form the interior surface of the duct to act as a moisture repellent and erosion-resistant coating. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
 3. Water-Based Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.
 - a. Adhesive VOC Content: 80 g/L or less.
 - b. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- H. Manufacturer: Subject to compliance with requirements, provide variable air volume terminals of one the following:
1. Envirotec
 2. Johnson Controls, Inc

3. Metal Aire
4. Price
5. Titus
6. Trane

PART 3 - EXECUTION

3.01 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 5, "Hangers and Supports" and with Section 23 05 29 "Hangers and Supports for HVAC Piping and Equipment."
- B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
 1. Where practical, install concrete inserts before placing concrete.
 2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
 3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes and for slabs more than 4 inches thick.
 4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes and for slabs less than 4 inches thick.
- C. Hangers Exposed to View: Threaded rod and angle or channel supports.
- D. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.02 TERMINAL UNIT INSTALLATION

- A. Install air terminal units according to NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."
- B. Install air terminal units level and plumb. Maintain sufficient clearance for normal service and maintenance.

3.03 CONNECTIONS

- A. Where installing piping adjacent to air terminal unit, allow space for service and maintenance.
- B. Comply with requirements in Section 23 31 13 "Metal Ducts" for connecting ducts to air terminal units.
- C. Make connections to air terminal units with flexible connectors complying with requirements in Section 23 33 00 "Air Duct Accessories."

3.04 IDENTIFICATION

- A. Label each air terminal unit with plan number, nominal airflow, and maximum and minimum factory-set airflows. Comply with requirements in Section 23 05 53 “Identification for HVAC Piping and Equipment” for equipment labels and warning signs and labels.

3.05 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. Perform the following tests and inspections:
 - 1. After installing air terminal units and after electrical circuitry has been energized, test for compliance with requirements.
 - 2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Air terminal unit will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

3.06 STARTUP SERVICE

- A. Perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.
 - 2. Verify that inlet duct connections are as recommended by air terminal unit manufacturer to achieve proper performance.
 - 3. Verify that controls and control enclosure are accessible.
 - 4. Verify that control connections are complete.
 - 5. Verify that nameplate and identification tag are visible.
 - 6. Verify that controls respond to inputs as specified.

3.07 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air terminal units.

END OF SECTION 23 36 16

SECTION 23 37 13
DIFFUSERS, REGISTERS, AND GRILLES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00.
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) requirements.

1.03 SUMMARY

- A. Section Includes:
 - 1. Louver faced diffusers.
 - 2. Rectangular and square ceiling diffusers.
 - 3. Bar registers.
 - 4. Fixed face grilles.
 - 5. Linear bar grilles.
- B. Related Sections:
 - 1. Section 23 33 00 “Air Duct Accessories” for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated, include the following:
 - 1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
 - 2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.
- B. Samples for Initial Selection: For diffusers, registers, and grilles with factory-applied color finishes.

PART 2 - PRODUCTS

2.01 CEILING DIFFUSERS

A. Louver Face Diffuser – CD1:

1. Devices shall be specifically designed for variable-air-volume flows.
2. Material: Aluminum.
3. Finish: Baked enamel, white.
4. Face Size: As indicated.
5. Face Style: Modular
6. Mounting: T-bar.
7. Pattern: Four-way, Adjustable core style.
8. Dampers: Opposed blade.

B. Rectangular and Square Ceiling Diffusers – CD2:

1. Devices shall be specifically designed for variable-air-volume flows.
2. Material: Aluminum.
3. Finish: Baked enamel, white.
4. Face Size: 24 by 24 inches
5. Face Style: Plaque.
6. Mounting: T-bar.
7. Pattern: Fixed.
8. Dampers: Opposed blade.

C. Linear Diffusers – LD1:

1. Material: Aluminum.
2. Finish: Baked enamel, white.
3. Core Construction: Integral.
4. Frame: 3/4 inches wide.
5. Mounting: Concealed.
6. Damper Type: Adjustable opposed blade.

7. Accessories: Endcaps, directional flow baffles, insulated plenum with duct connects. Coordinate plenum height with ceiling elements and their framing.

2.02 REGISTERS AND GRILLES

A. Adjustable Register – SS1, SS2:

1. Material: Aluminum.
2. Finish: Baked enamel, white.
3. Face Blade Arrangement: Parallel to short dimension spaced 3/4 inch apart.
4. Core Construction: Integral.
5. Rear-Blade Arrangement: Perpendicular to face blade spaced 3/4 inch apart.
6. Frame: 1-1/4 inches wide.
7. Mounting: Countersunk screw.
8. Damper Type: Adjustable opposed blade.
9. Accessories:
 - a. Front-blade gang operator.

B. Fixed Faced Grille – SR1:

1. Material: Steel.
2. Finish: Baked enamel, white.
3. Face Blade Arrangement: Horizontal spaced 3/4 inch apart.
4. Core Construction: Integral
5. Frame: 1-1/4 inches wide.
6. Mounting: Countersunk screw.

C. Fixed Faced Grille – SR2:

1. Material: Aluminum.
2. Finish: Baked enamel, white.
3. Face Blade Arrangement: Parallel to short dimension spaced 1/2 inch apart.
4. Core Construction: Integral.
5. Frame: 1-1/4 inches wide.
6. Mounting: Countersunk screw.

D. Perforated Grille – XG1:

1. Material: Steel backpan, with perforated aluminum face.
2. Finish: Baked enamel, white.
3. Face Size: 24 by 24 inches.
4. Duct Inlet: Square.
5. Face Style: Flush.
6. Mounting: T-bar.
7. Pattern Controller: None.
8. Dampers: Opposed blade.

E. Eggcrate Grille – XG2, EG1:

1. Material: Steel backpan, with perforated aluminum face.
2. Finish: Baked enamel, white.
3. Face Size: Neck size plus frame margin unless ceiling is lay in where it shall be 24 by 24 inches.
4. Duct Inlet: Square.
5. Face Style: Flush.
6. Mounting: GWB or T-bar.
7. Pattern Controller: None.
8. Dampers: Opposed blade.

2.03 SOURCE QUALITY CONTROL

- A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, “Method of Testing for Rating the Performance of Air Outlets and Inlets.”

2.04 MANUFACTURER

- A. Subject to compliance with requirements, provide diffusers of one of the following:
1. Metalaire
 2. Price Industries
 3. Titus Products Div.; Philips Industries, Inc.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Install diffusers, registers, and grilles level and plumb.
- B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect-Engineer for a determination of final location.
- C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.03 ADJUSTING

- A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 23 37 13

SECTION 23 43 15
AIR PURIFICATION SYSTEM

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00.
 - 1. Refer to "PART 2 – PRODUCTS" for all Buy America Build America Act (BABA) requirements.

1.03 DESCRIPTION OF WORK

- A. This section describes the design, performance and installation of an air purification system intended for use as part of another manufacturer's air handling unit or mounted on the duct as shown on the plans, details and equipment schedules.

1.04 REFERENCED CODES & STANDARDS

- A. The following codes and standards are referenced through out. The edition to be used is that currently enforced by the authority having jurisdiction (AHJ) or in absence of such direction that referenced by the current enforceable building code or as indicated by the contract documents, except where specifically referenced by this section of the specifications.
 - 1. ASHRAE Standards 62 & 52
 - 2. UL Standard 867
 - 3. Food & Drug Administration; 21CFR801.415; April 1, 2009
 - 4. National Electric Code NFPA 70, 1990

1.05 RELATED WORK

- A. Testing, Adjusting and Balancing
- B. Facility Access and Protection
- C. Ductwork
- D. Filters
- E. Water Piping
- F. Electrical Wiring
- G. Control Wiring

1.06 QUALITY ASSURANCE

- A. The Air Purification System shall be a product of an established manufacturer with installations in successful operation for a minimum of 10 years in the USA.
- B. A qualified representative from the manufacturer shall be available to inspect the installation of the air purification system to insure installation in accordance with manufacturer's recommendations.
- C. The complete Air Purification System shall be a product of single and an established manufacturer with installations in successful operation for a minimum of 10 years in the USA.
- D. The complete Air Purification System including the assembled Bi-polar ion generator, with power and control wiring, safety switches, airflow switches and controls shall be listed by either UL or ETL for commercial applications. Products submitted with UL or ETL certification for residential applications shall not be acceptable.
- E. Provide Indoor Air Quality calculations using the formulas within ASHRAE Standard 62.1 to validate acceptable indoor air quality at the quantity of outside air scheduled. The calculations shall have been independently validated to demonstrate compliance with ASHRAE Standard 62.1.

1.07 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data for ion generators including:
 - 1. Product performance data for filters, gauges, and housings.
 - 2. Product drawings detailing all physical, electrical, duct work, and control requirements.
- B. Operating & Maintenance Data: Submit O&M data and recommended spare parts lists.

1.08 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Deliver in factory fabricated shipping containers. Identify on outside of container type of product and location to be installed. Avoid crushing or bending.
- B. Store in original cartons and protect from weather and construction work traffic.
- C. Store indoors and in accordance with the manufacturers' recommendation for storage.

1.09 WARRANTY

- A. Equipment shall be warranted by the manufacturer against defects in material and workmanship for a period of eighteen months after shipment or twelve months from owner acceptance, whichever occurs first. Labor to replace equipment under warranty shall be provided by the owner or installing contractor.

1.10 MANUFACTURERS

- A. Manufacturer: Subject to compliance with requirements, provide Bi-polar Ion system of one of the following:
 - 1. Bioclimatic Air Systems

2. Global Plasma Solutions

PART 2 - PRODUCTS

2.01 GENERAL

- A. The air purification system(s) shall be of the size, type, arrangement and capacity indicated and required by the unit furnished and shall be of the manufacturer specified.

2.02 BI-POLAR IONIZATION DESIGN & PERFORMANCE CRITERIA

- A. Each piece of air handling equipment, so designated on the plans, details and/or equipment schedules shall contain a Bi-polar Ion system capable of:
 - 1. Effectively deactivating (neutralizing) microorganisms. (mold, bacteria, & virus)
 - 2. Reducing odors associated with human occupants to the extent that the minimum ventilation rates under the IAQ procedure may be attained.
 - 3. Capable of reducing static charges.
- B. No less than MERV 12 efficiency filters shall be provided in the air handling unit downstream from the Bi-polar Ion Generator to conform to ASHRAE Standard 62.1.
- D. Velocity Profile - The air velocity through the plenum or duct approaching the Bi-polar Ion Generator shall not exceed 500 fpm in the Bi-polar Ionization Section.
- E. Humidity - Relative humidity from 0 - 99% shall not cause damage, deterioration or dangerous conditions within the air purification system. For Bi-polar Ion Generators installed in the supply duct, the manufacturer shall provide additional BPI capacity to offset the loss caused by high humidity. Provide a safety circuit to interrupt power in the event of an internal system short circuit or arcing condition. The safety circuit must be in addition to the normal unit fuse or circuit breaker.

2.02. EQUIPMENT REQUIREMENTS

- A. Electrode Specifications (Bi-polar Ionization): Each Bi-polar Ionization unit shall include the required number of ion generators sized to the air handling equipment capacity. .
- B. Air Handler Mounted Units: Where so indicated on the plans and/or schedules Plasma Generator(s) shall be supplied and installed. The mechanical contractor shall mount the Plasma Generator and wire it to the remote mount power supply using the high voltage cables provided by the air purification manufacturer. A 115VAC or 230VAC circuit shall be provided to the plasma generator power supply panel. Each plasma generator shall be designed with an aluminum casing, liquid tight flexible conduit, and a high voltage quick connector.

2.03 BI-POLAR ION GENERATOR REQUIREMENTS

- A. Bi-Polar Ion Generator(s): Bi-polar Ion generator(s), capable of controlling gas phase contaminants shall be provided for all equipment listed in paragraph 2.2.
 - 1. The Bi-polar ionization system shall consist of Ion Generators, internal controls, safety door switches, airflow switches, and other accessories (as required) required for safe and efficient operation. The Ion Generators shall include a

BMS interface to indicate Ion Generator operation. The Ion Generators shall be installed where indicated on the plans.

- B. Ozone Generation: The operation of the Ion Generator electrodes shall not produce chemically detectable Ozone and shall conform to ASHRAE Standard 62.1 and the US CODE OF FEDERAL REGULATION item CFR 39-75 with respect to ozone generation.

2.04 ELECTRICAL REQUIREMENTS

- A. Wiring, conduit, and junction boxes shall be installed within housing plenums in accordance with NEC NFPA 70. Electrical service shall be 24 VAC. No “needles” shall be allowed to be in the air stream.

2.05 CONTROL REQUIREMENTS

- A. All Plasma Generators shall have internal short circuit protection, overload protection, and automatic fault reset.
- B. The ionization system shall be provided with a stand-alone, independent ion sensor designed for duct mounting to monitor the ion output and report to the BAS system that the ion device is working properly. Ion systems provided without an independent ion sensor, shall not be permitted. The control voltage to power the ion sensor shall be 12VDC or 24VAC to 240VAC and draw no more than 150mA of current. The sensor shall provide at minimum, dry contact status to the BAS and optionally a BacNet or Lonworks interface as specified on the control drawings. Manufacturers not providing a stand-alone ion sensor shall not be acceptable.
- C. The installing contractor shall mount and wire the Plasma device within the air-handling unit specified or as shown on the plans. The contractor shall follow all manufacturer IOM instructions during installation.

PART 3 - EXECUTION

3.01 ASSEMBLY AND ERECTION

- A. The air purification system manufacturer shall complete all interconnecting control and power wiring located within the roof curb unit.
- B. All equipment shall be assembled and installed in a workman like manner to the satisfaction of the owner, architect, and consulting engineer.
- C. Any material damaged by handling, water or moisture shall be replaced, by the mechanical contractor, at no cost to the owner.
- D. All equipment shall be protected from dust and damage on a daily basis throughout construction.
- E. Clean all components prior to commissioning.

3.02 TESTING

- A. Provide the manufacturers recommended electrical and static pressure tests.

3.03 COMMISSIONING & TRAINING

- A. A manufacturer's authorized representative shall be available to provide start-up supervision and training of owner's personnel in the proper operation and maintenance of all equipment (as required).
- B. Provide 5 copies of Operating and Maintenance Manuals.

END OF SECTION 23 45 15

SECTION 23 64 23.21
AIR-COOLED SCROLL WATER CHILLERS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00.
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) requirements.

1.03 SUMMARY

- A. Section includes packaged, air-cooled, electric-motor-driven, scroll water chillers.

1.04 DEFINITIONS

- A. BAS: Building automation system.
- B. COP: Coefficient of performance. The ratio of the rate of heat removal to the rate of energy input using consistent units for any given set of rating conditions.
- C. DDC: Direct digital control.
- D. EER: Energy-efficiency ratio. The ratio of the cooling capacity given in Btu/h to the total power input given in watts at any given set of rating conditions.
- E. GFI: Ground fault interrupt.
- F. IPLV: Integrated part-load value. A single-number part-load efficiency figure of merit for a single chiller calculated per the method defined by AHRI 550/590 and referenced to AHRI standard rating conditions.
- G. I/O: Input/output.
- H. kW/Ton: The ratio of total power input of the chiller in kilowatts to the net refrigerating capacity in tons at any given set of rating conditions.
- I. NPLV: Nonstandard part-load value. A single number part-load efficiency figure of merit for a single chiller calculated per the method defined by AHRI 550/590 and intended for operating conditions other than the AHRI standard rating conditions.
- J. SCCR: Short-circuit current rating.
- K. TEAO: Totally enclosed air over.

L. TENV: Totally enclosed nonventilating.

1.05 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include refrigerant, rated capacities, operating characteristics, and furnished specialties and accessories.
2. Performance at AHRI standard conditions and at conditions indicated.
3. Performance at AHRI standard unloading conditions.
4. Minimum evaporator flow rate.
5. Refrigerant capacity of water chiller.
6. Oil capacity of water chiller.
7. Fluid capacity of evaporator.
8. Characteristics of safety relief valves.
9. Force and moment capacity of each piping connection.

B. Shop Drawings: Complete set of manufacturer's prints of water chiller assemblies, control panels, sections and elevations, and unit isolation. Include the following:

1. Assembled unit dimensions.
2. Weight and load distribution.
3. Required clearances for maintenance and operation.
4. Size and location of piping and wiring connections.
5. Diagrams for power, signal, and control wiring.

1.06 INFORMATIONAL SUBMITTALS

A. Coordination Drawings:

1. Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - a. Structural supports.
 - b. Piping roughing-in requirements.
 - c. Wiring roughing-in requirements, including spaces reserved for electrical equipment.
 - d. Access requirements, including working clearances for mechanical controls and electrical equipment, and tube pull and service clearances.

2. Coordination drawings showing plan, section and elevation views, drawn to 1/8" = 1'-0".
3. Each view to show screened background with the following:
 - a. Column grids, beams, columns, and concrete housekeeping pads.
 - b. Layout with walls, floors, and roofs, including each room name and number.
 - c. Equipment and products of other trades that are located in vicinity of chillers and part of final installation, such as plumbing systems.
- B. Certificates: For certification required in "Quality Assurance" Article.
- C. Installation instructions.
- D. Source quality-control reports.
- E. Startup service reports.
- F. Sample Warranty: For special warranty.

1.07 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each water chiller to include in emergency, operation, and maintenance manuals.
- B. Spare Parts List: Recommended spare parts list with quantity for each.
- C. Touchup Paint Description: Detailed description of paint used in application of finish coat to allow for procurement of a matching paint.
- D. Instructional Videos: Including those that are prerecorded and those that are recorded during training.

1.08 QUALITY ASSURANCE

- A. AHRI Certification: Certify chiller according to AHRI 590 certification program.

1.09 DELIVERY, STORAGE, AND HANDLING

- A. Ship water chillers from the factory fully charged with refrigerant and filled with oil.

1.10 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of water chillers that fail in materials or workmanship within specified warranty period.
 1. Extended warranties include, but are not limited to, the following:
 - a. Complete chiller including refrigerant and oil charge.
 - b. Parts and labor.

2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. AHRI Rating: Rate water chiller performance according to requirements in AHRI 550/590.
- B. ASHRAE Compliance: ASHRAE 15 for safety code for mechanical refrigeration.
- C. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
- D. ASME Compliance: Fabricate and stamp water chiller heat exchangers to comply with ASME Boiler and Pressure Vessel Code.
- E. Comply with NFPA 70.
- F. Comply with requirements of UL 1995, "Heating and Cooling Equipment," and include label by a qualified testing agency showing compliance.
- G. Operation Following Loss of Normal Power:
 1. Equipment, associated factory- and field-installed controls, and associated electrical equipment and power supply connected to backup power system shall automatically return equipment and associated controls to the operating state occurring immediately before loss of normal power without need for manual intervention by an operator when power is restored either through a backup power source, or through normal power if restored before backup power is brought on-line.
 2. See drawings for equipment served by backup power systems.
 3. Provide means and methods required to satisfy requirement even if not explicitly indicated.
- H. Outdoor Installations:
 1. Chiller shall be suitable for outdoor installation indicated. Provide adequate weather protection to ensure reliable service life over a 25 year period with minimal degradation due to exposure to outdoor ambient conditions.
 2. Chillers equipped to provide safe and stable operation while achieving performance indicated when operating at extreme outdoor temperatures encountered by the installation. Review historical weather database and provide equipment that can operate at extreme outdoor temperatures recorded over past 30-year period.

2.02 MANUFACTURED UNITS

- A. Description: Factory-assembled and run-tested water chiller complete with compressor(s), compressor motors and motor controllers, evaporator, condenser with fans, electrical power, controls, and indicated accessories.

- B. Sound-reduction package shall have the following:
 - 1. Acoustic enclosure around compressors.
 - 2. Reduced-speed fans with acoustic treatment.
 - 3. Designed to reduce sound level without affecting performance.

2.03 CABINET

- A. Base: Galvanized-steel base extending the perimeter of water chiller. Secure frame, compressors, and evaporator to base to provide a single-piece unit.
- B. Frame: Rigid galvanized-steel frame secured to base and designed to support cabinet, condenser, control panel, and other chiller components not directly supported from base.
- C. Casing: Galvanized steel.
- D. Finish: Coat base, frame, and casing with a corrosion-resistant coating capable of withstanding a 500-hour salt-spray test according to ASTM B 117.

2.04 COMPRESSOR-DRIVE ASSEMBLIES

- A. Compressors:
 - 1. Description: Positive-displacement direct drive with hermetically sealed casing.
 - 2. Each compressor provided with suction and discharge service valves, crankcase oil heater, and suction strainer.
 - a. For multiple compressor assemblies, it is acceptable to isolate each compressor assembly in lieu of each compressor.
 - 3. Operating Speed: Nominal 3600 rpm for 60-Hz applications.
 - 4. Capacity Control: On-off compressor cycling, plus hot-gas bypass.
 - a. Digital compressor unloading is an acceptable alternative to achieve capacity control.
 - 5. Oil Lubrication System: Automatic pump with strainer, sight glass, filling connection, filter with magnetic plug or removable magnet in sump, and initial oil charge.
 - a. Manufacturer's other standard methods of providing positive lubrication are acceptable in lieu of an automatic pump.
 - 6. Vibration Isolation: Mount individual compressors on vibration isolators.
 - a. For multiple compressor assemblies, it is acceptable to isolate each compressor assembly in lieu of each compressor.
- B. Compressor Motors:
 - 1. Hermetically sealed and cooled by refrigerant suction gas.

2. High-torque, two-pole induction type with inherent thermal-overload protection on each phase.
- C. Compressor Motor Controllers:
1. Across the Line: NEMA ICS 2, Class A, full voltage, nonreversing.

2.05 REFRIGERATION

- A. Refrigerant: R-32 or R-454b. Classified as Safety Group A2L according to ASHRAE 34.
- B. Refrigerant Compatibility: Parts exposed to refrigerants shall be fully compatible with refrigerants, and pressure components shall be rated for refrigerant pressures.
- C. Refrigerant Circuit: Each circuit shall include an electronic or a thermal-expansion valve, refrigerant charging connections, a hot-gas muffler, compressor suction and discharge shutoff valves, a liquid-line shutoff valve, a replaceable-core filter-dryer, a sight glass with moisture indicator, a liquid-line solenoid valve, and an insulated suction line.
- D. Refrigerant Isolation: Factory install positive shutoff isolation valves in the compressor discharge line and the refrigerant liquid-line to allow the isolation and storage of the refrigerant charge in the chiller condenser.
1. For multiple compressor assemblies, it is acceptable to isolate each compressor assembly in each circuit in lieu of each compressor.
- E. Pressure Relief Device:
1. Comply with requirements in ASHRAE 15, ASHRAE 147, and applicable portions of ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
 2. Select and configure pressure relief devices to protect against corrosion and inadvertent release of refrigerant.
 3. ASME-rated, spring-loaded, pressure relief valve; single- or multiple-reseating type. Pressure relief valve(s) shall be provided for each heat exchanger.

2.06 EVAPORATOR

- A. Brazed Plate:
1. Direct-expansion, single-pass, brazed-plate design.
 2. Type 304 or 316 stainless-steel construction.
 3. Code Compliance: Tested according to ASME Boiler and Pressure Vessel Code.
 4. Fluid Nozzles: Terminate with mechanical-coupling end connections for connection to field piping. Furnish flange adapters to mate to flanged piping.
 5. Inlet Strainer: Factory-furnished, 20-mesh strainer for field installation in supply piping to evaporator. Manufacturer has option to factory install strainer.

- B. Flow Switch: Factory-furnished and -installed, thermal-type flow switch wired to chiller operating controls.

2.07 AIR-COOLED CONDENSER

- A. Coil(s) with integral subcooling on each circuit.
- B. Aluminum Microchannel Coils:
 - 1. Series of flat tubes containing a series of multiple, parallel-flow microchannels layered between refrigerant header manifolds.
 - 2. Single- or multiple-pass arrangement.
 - 3. Construct fins, tubes, and header manifolds of aluminum alloy treated with a corrosion-resistant coating.
- C. Corrosion-Resistant Coating: Coat coils with an epoxy or a phenolic corrosion-resistant coating after fabrication capable of withstanding a 5000-hour salt-spray test according to ASTM B 117 applied to both the coil and coil frames. Coating shall also include a UV-resistance urethane top-coat to provide resistance to degradation from direct sunlight
- D. Fans: VFD's without Line Reactors, Direct-drive propeller type with statically and dynamically balanced fan blades, arranged for vertical air discharge.
- E. Fan Motors: TENV or TEAO enclosure, with sealed and permanently lubricated bearings, and having built-in overcurrent- and thermal-overload protection.
 - 1. Overcurrent- and thermal-overload protection not integral to motor is acceptable if provided with chiller electrical power package.
- F. Fan Guards: Removable steel safety guards with corrosion-resistant coating.

2.08 INSULATION

- A. Closed-cell, flexible, elastomeric thermal insulation complying with ASTM C 534/C 534M, Type I for tubular materials and Type II for sheet materials.
 - 1. Thickness: 3/4 inch.
- B. Adhesive: As recommended by insulation manufacturer.
- C. Factory-applied insulation over all cold surfaces of chiller capable of forming condensation. Components shall include, but not be limited to, evaporator, evaporator water boxes including nozzles, refrigerant suction pipe from evaporator to compressor, cold surfaces of compressor, refrigerant-cooled motor, and auxiliary piping.
 - 1. Apply adhesive to 100 percent of insulation contact surface.
 - 2. Before insulating steel surfaces, prepare surfaces for paint, and prime and paint as indicated for other painted components. Do not insulate unpainted steel surfaces.
 - 3. Seal seams and joints to provide a vapor barrier.

4. After adhesive has fully cured, paint exposed surfaces of insulation to match other painted parts.
5. Manufacturer has option to factory or field insulate chiller components to reduce potential for damage during installation.
6. Field-Applied Insulation:
 - a. Components that are not factory insulated shall be field insulated to comply with requirements indicated.
 - b. Manufacturer shall be responsible for chiller insulation whether factory or field installed to ensure that manufacturer is the single point of responsibility for chillers.
 - c. Manufacturer's factory-authorized service representative shall instruct and supervise installation of field-applied insulation.
 - d. After field-applied insulation is complete, paint insulation to match factory-applied finish.

2.09 ELECTRICAL

- A. Factory installed and wired, and functionally tested at factory before shipment.
- B. Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to water chiller.
- C. House in a unit-mounted, NEMA 250, Type 3R enclosure with hinged access door with lock and key or padlock and key.
- D. Wiring shall be numbered and color-coded to match wiring diagram.
- E. Factory wiring shall be located outside of an enclosure in a metal raceway. Terminal connections shall be made with not more than a 24-inch length of liquidtight or flexible metallic conduit.
- F. Field power interface shall be to NEMA KS 1, heavy-duty, nonfused disconnect switch. Minimum SCCR according to UL 508 shall be as required by electrical power distribution system.
- G. Each motor shall have branch power circuit and controls with one of the following disconnecting means having SCCR to match main disconnecting means:
 1. NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 60947-4-1.
 2. NEMA KS 1, heavy-duty, nonfusible switch.
 3. UL 489, motor-circuit protector (circuit breaker) with field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
- H. Each motor shall have overcurrent protection.

- I. Overload relay sized according to UL 1995, or an integral component of water chiller control microprocessor.
- J. Phase-Failure and Undervoltage: Solid-state sensing with adjustable settings.
- K. Controls Transformer: Unit-mounted transformer with primary and secondary fuses and sized with enough capacity to operate electrical load plus spare capacity.
- L. Control Relays: Auxiliary and adjustable time-delay relays, or an integral to water chiller microprocessor.
- M. Indicate the following for water chiller electrical power supply: Information shall also be available through DDC interface.
 - 1. Current, phase to phase, for all three phases.
 - 2. Voltage, phase to phase and phase to neutral for all three phases.
 - 3. Three-phase real power (kilowatts).
 - 4. Three-phase reactive power (kilovolt amperes reactive).
 - 5. Power factor.
 - 6. Running log of total power versus time (kilowatt hours).
 - 7. Fault log, with time and date of each.

2.10 CONTROLS

- A. Factory installed and wired, and functionally tested at factory before shipment.
- B. Provide low ambient Control.
- C. Standalone, microprocessor based, with all memory stored in nonvolatile memory so that reprogramming is not required on loss of electrical power.
- D. Enclosure: Share enclosure with electrical power devices or provide a separate enclosure of matching construction.
- E. Operator Interface: Keypad or pressure-sensitive touch screen. Multiple-character, digital display. Display the following:
 - 1. Date and time.
 - 2. Operating or alarm status.
 - 3. Operating hours.
 - 4. Temperature and pressure of operating set points.
 - 5. Chilled-water entering and leaving temperatures.
 - 6. Refrigerant pressures in evaporator and condenser.

7. Saturation temperature in evaporator and condenser.
8. No cooling load condition.
9. Elapsed time meter (compressor run status).
10. Pump status.
11. Antirecycling timer status.
12. Percent of maximum motor amperage.
13. Current-limit set point.
14. Number of compressor starts.
15. Alarm history with retention of operational data before unit shutdown.
16. Superheat.

F. Control Functions:

1. Manual or automatic startup and shutdown time schedule.
2. Capacity control based on evaporator leaving-fluid temperature.
3. Capacity control compensated by rate of change of evaporator entering-fluid temperature.
4. Chilled-water entering and leaving temperatures, control set points, and motor load limit.
5. Current limit and demand limit.
6. External water chiller emergency stop.
7. Antirecycling timer.
8. Automatic lead-lag switching.

G. Manual-Reset Safety Controls: The following conditions shall shut down water chiller and require manual reset:

1. Low evaporator pressure or high condenser pressure.
2. Low chilled-water temperature.
3. Refrigerant high pressure.
4. High or low oil pressure.
5. High oil temperature.
6. Loss of chilled-water flow.

- 7. Control device failure.
- H. DDC System Interface: Factory-install hardware and software to enable system to monitor, control, and display chiller status and alarms.
 - 1. Communication Interface: ASHRAE 135 (BACnet) or Industry-accepted open-protocol communication interface shall enable control system operator to remotely control and monitor the water chiller from an operator workstation. Control features and monitoring points displayed locally at water chiller control panel shall be available through DDC system for HVAC.
- I. Factory-installed wiring outside of enclosures shall be in NFPA 70-complaint raceway. Make terminal connections with liquidtight or flexible metallic conduit.

2.11 SOURCE QUALITY CONTROL

- A. Perform functional test of water chillers before shipping.
- B. Factory test and inspect evaporator according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1. Stamp with ASME label.
- C. For water chillers located outdoors, rate sound power level according to AHRI 370 procedure.

2.12 MANUFACTURER

- A. Subject to compliance with requirements, provide air handling units of one the following:
 - 1. Carrier
 - 2. Daikin
 - 3. Trane

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Before water chiller installation, examine roughing-in for equipment support, anchor-bolt sizes and locations, piping, controls, and electrical connections to verify actual locations, sizes, and other conditions affecting water chiller performance, maintenance, and operations.
 - 1. Water chiller locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping, controls, and electrical connections.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 WATER CHILLER INSTALLATION

- A. Coordinate sizes and locations of bases with actual equipment provided. Cast anchor-bolt inserts into concrete bases.
- B. Equipment Mounting:

1. Install water chillers on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 03 30 00 "Cast-in-Place Concrete."
- C. Maintain manufacturer's recommended clearances for service and maintenance.
 - D. Maintain clearances required by governing code.
 - E. Chiller manufacturer's factory-trained service personnel shall charge water chiller with refrigerant if not factory charged and fill with oil if not factory installed.
 - F. Install separate devices furnished by manufacturer and not factory installed.
 1. Chillers shipped in multiple major assemblies shall be field assembled by chiller manufacturer's factory-trained service personnel.

3.03 PIPING CONNECTIONS

- A. Comply with requirements in Section 23 21 13 "Hydronic Piping" and Section 23 21 16 "Hydronic Piping Specialties." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where installing piping adjacent to chillers, allow space for service and maintenance.
- C. Evaporator Fluid Connections:
 1. Connect to evaporator inlet with shutoff valve, strainer, flexible connector, thermometer, and plugged tee with pressure gage.
 2. Connect to evaporator outlet with shutoff valve, balancing valve, flexible connector, flow switch, thermometer, plugged tee with pressure gage, flow meter, and drain connection with valve.
 3. Make connections to water chiller with a flange or mechanical coupling.
- D. Connect each drain connection with a drain valve, full size of drain connection.
- E. Connect each chiller vent connection with a manual vent, full size of vent connection.

3.04 ELECTRICAL POWER CONNECTIONS

- A. Connect wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."
- B. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."
- C. Provide nameplate for each electrical connection indicating electrical equipment designation and circuit number feeding connection. Nameplate shall be laminated phenolic layers of black with engraved white letters at least 1/2 inch high. Locate nameplate where easily visible.

3.05 CONTROLS CONNECTIONS

- A. Install control and electrical power wiring to field-mounted control devices.
- B. Connect control wiring between chillers and other equipment to interlock operation as required to provide a complete and functioning system.
- C. Connect control wiring between chiller control interface and DDC system for remote monitoring and control of chillers. Comply with requirements in Section 23 09 23 "Direct Digital Control (DDC) System for HVAC."
- D. Provide nameplate on face of chiller control panel indicating control equipment designation serving chiller and the I/O point designation for each control connection. Nameplate shall be laminated phenolic layers of black with engraved white letters at least 1/2 inch high.

3.06 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
- B. Inspect field-assembled components, equipment installation, and piping and electrical connections for proper assemblies, installations, and connections.
- C. Complete installation and startup checks according to manufacturer's written instructions and perform the following:
 - 1. Verify that refrigerant charge is sufficient and water chiller has been leak tested.
 - 2. Verify that pumps are installed and functional.
 - 3. Verify that thermometers and gages are installed.
 - 4. Operate water chiller for run-in period.
 - 5. Check bearing lubrication and oil levels.
 - 6. Verify that refrigerant pressure relief device for chillers installed indoors is vented outside.
 - 7. Verify proper motor rotation.
 - 8. Verify static deflection of vibration isolators, including deflection during water chiller startup and shutdown.
 - 9. Verify and record performance of water chiller protection devices.
 - 10. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.
- D. Visually inspect chiller for damage before starting. Repair or replace damaged components, including insulation. Do not start chiller until damage that is detrimental to operation has been corrected.
- E. Prepare a written startup report that records results of tests and inspections.

3.07 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain water chillers.
 - 1. Instructor shall be factory trained and certified.
 - 2. Provide not less than eight hours of training.
 - 3. Train personnel in operation and maintenance and to obtain maximum efficiency in plant operation.
 - 4. Provide instructional videos showing general operation and maintenance that are coordinated with operation and maintenance manuals.
 - 5. Obtain Owner sign-off that training is complete.
 - 6. Owner training shall be held at Project site.

END OF SECTION 23 64 23.21

SECTION 23 72 00
AIR-TO-AIR ENERGY RECOVERY EQUIPMENT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00.
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) requirements.

1.03 SUMMARY

- A. Section Includes:
 - 1. Heat wheels.
- B. Related Requirements:
 - 1. Section 23 73 13 “Modular Indoor Central Station Air Handling Units

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, furnished specialties, and accessories.
- B. Shop Drawings: For air-to-air energy recovery equipment. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Wiring Diagrams: For power, signal, and control wiring.

1.05 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Plans, elevations, and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:
- B. Field quality-control reports.

1.06 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For air-to-air energy recovery equipment to include in maintenance manuals.

1.07 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Filters: One set(s) of each type of filter specified.
 - 2. Fan Belts: One set(s) of belts for each belt-driven fan in energy recovery units.
 - 3. Wheel Belts: One set(s) of belts for each heat wheel.

1.08 QUALITY ASSURANCE

- A. 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.
- B. ARI Compliance:
 - 1. Capacity ratings for air-to-air energy recovery equipment shall comply with ARI 1060, "Performance Rating of Air-to-Air Heat Exchangers for Energy Recovery Ventilation Equipment."
 - 2. Capacity ratings for air coils shall comply with ARI 410, "Forced-Circulation Air-Cooling and Air-Heating Coils."
- C. ASHRAE Compliance:
 - 1. Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
 - 2. Capacity ratings for air-to-air energy recovery equipment shall comply with ASHRAE 84, "Method of Testing Air-to-Air Heat Exchangers."
- D. NRCA Compliance: Roof curbs for roof-mounted equipment shall be constructed according to recommendations of NRCA.
- E. UL Compliance:
 - 1. Packaged heat recovery ventilators shall comply with requirements in UL 1812, "Ducted Heat Recovery Ventilators"; or UL 1815, "Nonducted Heat Recovery Ventilators."
 - 2. Electric coils shall comply with requirements in UL 1995, "Heating and Cooling Equipment."

1.09 COORDINATION

- A. Coordinate layout and installation of air-to-air energy recovery equipment and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.
- B. Coordinate sizes and locations of concrete bases with actual equipment provided.
- C. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

PART 2 - PRODUCTS

2.01 HEAT WHEELS

- A. Casing:
 - 1. Steel with standard factory-painted finish.
 - 2. Integral purge section limiting carryover of exhaust air to between 0.05 percent at 1.6-inch wg and 0.20 percent at 4-inch wg differential pressure.
 - 3. Casing seals on periphery of rotor and on duct divider and purge section.
 - 4. Support vertical rotors on grease-lubricated ball bearings having extended grease fittings or permanently lubricated bearings. Support horizontal rotors on tapered roller bearing.
- B. Rotor: Polymer segmented wheel strengthened with radial spokes impregnated with nonmigrating, water-selective, molecular-sieve desiccant coating.
 - 1. Maximum Solid Size for Media to Pass: 800 micrometer.
- C. Drive: Fractional horsepower motor and gear reducer, with speed changed by variable frequency controller and self-adjusting multilink belt around outside of rotor.
 - 1. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 23 05 13 "Common Motor Requirements for HVAC Equipment."
 - 2. 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.
- D. Controls:
 - 1. Starting relay, factory mounted and wired, and manual motor starter for field wiring.
 - 2. Variable frequency controller, factory mounted and wired, permitting input of field connected 4-20 mA or 1-10-V control signal.
 - 3. Speed Settings: Adjustable settings for maximum and minimum rotor speed limits.
- E. Extended-Surface, Disposable Panel Filters:

1. Comply with NFPA 90A.
2. Filter Holding Frames: Arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lift out from access plenum.
3. Factory-fabricated, dry, extended-surface type.
4. Thickness: 2 inches.
5. Initial Resistance: 0.15 inches wg.
6. Recommended Final Resistance: 0.35 inches wg.
7. Minimum Arrestance: 90, according to ASHRAE 52.1.
8. MERV: 7, according to ASHRAE 52.2.
9. Media: Fibrous material formed into deep-V-shaped pleats and held by self-supporting wire grid.
10. Media-Grid Frame: Nonflammable cardboard.
11. Mounting Frames: Welded, galvanized steel with gaskets and fasteners, suitable for bolting together into built-up filter banks.

2.02 CAPACITIES AND CHARACTERISTICS

- A. Refer to the schedules on the drawings for capacities and characteristics.

2.03 ENERGY RECOVERY MEDIA MANUFACTURER

- A. Subject to compliance with requirements, provide energy recovery media of one the following:
 1. Airxchange, Inc.
 2. Novel Aire Technology
 3. SEMCO LLC

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine casing insulation materials and filter media before air-to-air energy recovery equipment installation. Reject insulation materials and filter media that are wet, moisture damaged, or mold damaged.
- C. Examine roughing-in for electrical services to verify actual locations of connections before installation.

- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Install heat wheels so supply and exhaust airstreams flow in opposite directions and rotation is away from exhaust side to purge section to supply side.
 - 1. Install access doors in both supply and exhaust ducts, both upstream and downstream, for access to wheel surfaces, drive motor, and seals.
 - 2. Install removable panels or access doors between supply and exhaust ducts on building side for bypass during startup.
 - 3. Access doors and panels are specified in Section 23 33 00 “Air Duct Accessories.”
- B. Install floor-mounted units on 4-inch- high concrete base.
- C. Install units with clearances for service and maintenance.
- D. Install new filters at completion of equipment installation and before testing, adjusting, and balancing.
- E. Pipe drains from drain pans to nearest floor drain; use ASTM B 88, Type L, drawn-temper copper water tubing with soldered joints, same size as condensate drain connection.

3.03 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- B. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- C. Tests and Inspections:
 - 1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 2. Adjust seals and purge.
 - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - 4. Set initial temperature and humidity set points.
 - 5. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
- D. Air-to-air energy recovery equipment will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.04 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air-to-air energy recovery units.

END OF SECTION 23 72 00

SECTION 23 73 13
MODULAR INDOOR CENTRAL-STATION AIR-HANDLING UNITS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00.
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) requirements.

1.03 SUMMARY

- A. Section Includes:
 - 1. Variable-air-volume, single-zone air-handling units.
- B. Related Requirements:
 - 1. Section 23 72 00 “Air-to-Air Energy Recovery Equipment”

1.04 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Casing panels shall be self-supporting and capable of withstanding 125 percent of internal static pressures indicated, without panel joints exceeding a deflection of L/240 where “L” is the unsupported span length within completed casings.

1.05 ACTION SUBMITTALS

- A. Product Data: For each air-handling unit indicated.
 - 1. Unit dimensions and weight.
 - 2. Cabinet material, metal thickness, finishes, insulation, and accessories.
 - 3. Fans:
 - a. Certified fan-performance curves with system operating conditions indicated.
 - b. Certified fan-sound power ratings.
 - c. Fan construction and accessories.
 - d. Motor ratings, electrical characteristics, and motor accessories.
 - 4. Certified coil-performance ratings with system operating conditions indicated.

5. Dampers, including housings, linkages, and operators.
6. Filters with performance characteristics.

1.06 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Floor plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 1. Mechanical-room layout and relationships between components and adjacent structural and mechanical elements.
 2. Support location, type, and weight.
 3. Field measurements.
- B. Source quality-control reports.
- C. Field quality-control reports.

1.07 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For air-handling units to include in emergency, operation, and maintenance manuals.

1.08 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Filters: One set for each air-handling unit.

1.09 QUALITY ASSURANCE

- A. 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.
- B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of air-handling units and components.
- C. ARI Certification: Air-handling units and their components shall be factory tested according to ARI 430, "Central-Station Air-Handling Units," and shall be listed and labeled by ARI.
- D. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- E. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
- F. Comply with NFPA 70.

1.10 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.

PART 2 - PRODUCTS

2.01 UNIT CASINGS

- A. General Fabrication Requirements for Casings:
 - 1. Forming: Form walls, roofs, and floors with at least two breaks at each joint.
 - 2. Casing Joints: Sheet metal screws or pop rivets.
 - 3. Sealing: Seal all joints with water-resistant sealant.
 - 4. Factory Finish for Galvanized-Steel Casings: None.
 - 5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- B. Casing Insulation and Adhesive:
 - 1. Materials: 2" nominal thick, foam insulation with R-value not less than R-13.
 - 2. Location and Application: Encased between outside and inside casing.
- C. Inspection and Access Panels and Access Doors:
 - 1. Panel and Door Fabrication: Formed and reinforced, double-wall and insulated panels of same materials and thicknesses as casing.
 - 2. Access Doors:
 - a. Hinges: A minimum of two ball-bearing hinges or stainless-steel piano hinge and two wedge-lever-type latches, operable from inside and outside. Arrange doors to be opened against air-pressure differential.
 - b. Gasket: Neoprene, applied around entire perimeters of panel frames.
 - c. Fabricate windows in fan section doors of double-glazed, wire-reinforced safety glass with an air space between panes and sealed with interior and exterior rubber seals.
 - d. Size: At least 18 inches wide by full height of unit casing up to a maximum height of 60 inches.
 - 3. Locations and Applications:
 - a. Fan Section: Doors.
 - b. Access Section: Doors.
 - c. Coil Section: Doors.

- d. Damper Section: Doors.
 - e. Filter Section: Doors large enough to allow periodic removal and installation of filters.
 - f. Mixing Section: Doors.
- D. Condensate Drain Pans:
- 1. Fabricated with one percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) to direct water toward drain connection.
 - a. Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1.
 - b. Depth: A minimum of 2 inches deep.
 - 2. Formed sections.
 - 3. Single-wall, microbial resistant coated galvanized steel or stainless-steel sheet. 2” thickness of insulation under drain pan.
 - 4. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end or both ends of pan.
 - a. Minimum Connection Size: NPS 2.
 - 5. Units with stacked coils shall have an intermediate drain pan to collect condensate from top coil.
- E. Air-Handling-Unit Mounting Frame: Formed galvanized-steel channel or structural channel supports, designed for low deflection, welded with integral lifting lugs.

2.02 FAN, DRIVE, AND MOTOR SECTION

- A. Fan and Drive Assemblies: Statically and dynamically balanced and designed for continuous operation at maximum-rated fan speed and motor horsepower.
- 1. Shafts: Designed for continuous operation at maximum-rated fan speed and motor horsepower, and with field-adjustable alignment.
 - a. Turned, ground, and polished hot-rolled steel with keyway. Ship with a protective coating of lubricating oil.
 - b. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.
- B. Plenum Fan Housings: Steel frame and panel; fabricated without fan scroll and volute housing.
- C. Direct Drive Plenum, Airfoil, Centrifugal Fan Wheels: Smooth-curved inlet flange, backplate, and hollow die-formed airfoil-shaped blades continuously welded at tip flange and backplate; cast-iron or cast-steel hub riveted to backplate and fastened to shaft with set screws.

- D. Fan Shaft Bearings:
 - 1. Grease-Lubricated, Tapered-Roller Bearings: Self-aligning, pillow-block type with double-locking collars and 2-piece, cast-iron housing with grease lines extended to outside unit and a rated life of 120,000 hours according to ABMA 11.
- E. Internal Vibration Isolation: Fans shall be factory mounted with manufacturer's standard restrained vibration isolation mounting devices having a minimum static deflection of 1 inch.
- F. Motor: Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 23 05 13 "Common Motor Requirements for HVAC Equipment."
 - 1. NEMA Premium (TM) efficient motors as defined in NEMA MG 1.
 - 2. 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.
 - 3. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
 - 4. Mount unit-mounted disconnect switches on exterior of unit.

2.03 COIL SECTION

- A. General Requirements for Coil Section:
 - 1. Comply with ARI 410.
 - 2. Fabricate coil section to allow removal and replacement of coil for maintenance and to allow in-place access for service and maintenance of coil(s).
 - 3. Coils shall not act as structural component of unit.

2.04 AIR FILTRATION SECTION

- A. General Requirements for Air Filtration Section:
 - 1. Comply with NFPA 90A.
 - 2. Provide minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
 - 3. Provide filter holding frames arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lifted out from access plenum.
- B. Extended-Surface, Disposable Panel Filters:
 - 1. Factory-fabricated, dry, extended-surface type with antimicrobial treatment.
 - 2. Thickness: 2 inches.
 - 3. Merv (ASHRAE 52.2): 8.

4. Media: Fibrous material formed into deep-V-shaped pleats and held by self-supporting wire grid.
 5. Media-Grid Frame: Nonflammable cardboard.
 6. Mounting Frames: Welded, galvanized steel, with gaskets and fasteners, suitable for bolting together into built-up filter banks.
- C. Extended-Surface, Nonsupported-Media Filters:
1. Factory-fabricated, dry, extended-surface, self-supporting type.
 2. Merv (ASHRAE 52.2): 13.
 3. Media: Fibrous material constructed so individual pleats are maintained in tapered form by flexible internal supports under rated-airflow conditions.
 4. Filter-Media Frame: Galvanized steel.
 5. Mounting Frames: Welded, galvanized steel, with gaskets and fasteners, suitable for bolting together into built-up filter banks with space for prefilter.
- D. Filter Gage:
1. 2-inch- diameter, diaphragm-actuated dial in metal case.
 2. Vent valves.
 3. Black figures on white background.
 4. Front recalibration adjustment.
 5. 3 percent of full-scale accuracy.
 6. Range: 0- to 2.0-inch wg.
 7. Accessories: Static-pressure tips with integral compression fittings, 1/4-inch aluminum tubing, and 2- or 3-way vent valves.

2.05 DAMPERS

- A. General Requirements for Dampers: Leakage rate, according to AMCA 500, "Laboratory Methods for Testing Dampers for Rating," shall not exceed 2 percent of air quantity at 2000-fpm face velocity through damper and 4-inch wg pressure differential.
- B. Damper Operators: Comply with requirements in Section 23 09 23.12 "Control Dampers."
- C. Outdoor- and Return-Air Dampers: Low-leakage, double-skin, airfoil-blade, galvanized-steel dampers with compressible jamb seals and extruded-vinyl blade edge seals in opposed blade arrangement with steel operating rods rotating in sintered bronze or nylon bearings mounted in a single galvanized-steel frame, and with operating rods connected with a common linkage. Leakage rate shall not exceed 5 cfm/sq. ft. at 1-inch wg and 9 cfm/sq. ft. at 4-inch wg.

2.06 CAPACITIES AND CHARACTERISTICS

- A. Casing:
 - 1. Outside Casing: G90 galvanized steel.
 - 2. Inside Casing: G90 galvanized steel, solid.
 - 3. Floor Plate: G90 galvanized steel, solid.
 - 4. Insulation Thickness: 2 inches.
 - 5. Static-Pressure Classifications: 8-inch wg.

2.07 SOURCE QUALITY CONTROL

- A. Fan Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Fans shall bear AMCA-certified sound ratings seal.
- B. Fan Performance Rating: Factory test fan performance for airflow, pressure, power, air density, rotation speed, and efficiency. Rate performance according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating."
- C. Water Coils: Factory tested to 300 psig according to ARI 410 and ASHRAE 33.

2.08 MANUFACTURER

- A. Subject to compliance with requirements, provide air handling units of one the following:
 - 1. Carrier
 - 2. Daikin
 - 3. JCI/York
 - 4. Trane

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine casing insulation materials and filter media before air-handling unit installation. Reject insulation materials and filter media that are wet, moisture damaged, or mold damaged.
- C. Examine roughing-in for hydronic, and condensate drainage piping systems and electrical services to verify actual locations of connections before installation.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Equipment Mounting:
 - 1. Install air-handling units on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 03 30 00 "Cast-in-Place Concrete."
- B. Arrange installation of units to provide access space around air-handling units for service and maintenance.
- C. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing, with new, clean filters.
- D. Install filter-gage, static-pressure taps upstream and downstream of filters. Mount filter gages on outside of filter housing or filter plenum in accessible position. Provide filter gages on filter banks, installed with separate static-pressure taps upstream and downstream of filters.

3.03 CONNECTIONS

- A. Comply with requirements for piping specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to air-handling unit to allow service and maintenance.
- C. Connect piping to air-handling units mounted on vibration isolators with flexible connectors.
- D. Connect condensate drain pans using NPS 1-1/4, ASTM B 88, Type M copper tubing. Extend to nearest equipment or floor drain. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.
- E. Chilled-Water Piping: Comply with applicable requirements in Section 23 21 13 "Hydronic Piping" and Section 23 21 16 Hydronic Piping Specialties." Install shutoff valve and union or flange at each coil supply connection. Install balancing valve and union or flange at each coil return connection.
- F. Connect duct to air-handling units with flexible connections. Comply with requirements in Section 23 33 00 "Air Duct Accessories."

3.04 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 - 1. Leak Test: After installation, fill water coils with water, and test coils and connections for leaks.
 - 2. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

- C. Air-handling unit or components will be considered defective if unit or components do not pass tests and inspections.
- D. Prepare test and inspection reports.

3.05 STARTUP SERVICE

- A. Perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.
 - 2. Verify that shipping, blocking, and bracing are removed.
 - 3. Verify that unit is secure on mountings and supporting devices and that connections to piping, ducts, and electrical systems are complete. Verify that proper thermal-overload protection is installed in motors, controllers, and switches.
 - 4. Verify proper motor rotation direction, free fan wheel rotation, and smooth bearing operations. Reconnect fan drive system, align belts, and install belt guards.
 - 5. Verify that bearings, pulleys, belts, and other moving parts are lubricated with factory-recommended lubricants.
 - 6. Verify that outdoor- and return-air mixing dampers open and close, and maintain minimum outdoor-air setting.
 - 7. Comb coil fins for parallel orientation.
 - 8. Install new, clean filters.
 - 9. Verify that manual and automatic volume control and fire and smoke dampers in connected duct systems are in fully open position.
- B. Starting procedures for air-handling units include the following:
 - 1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated rpm.
 - 2. Measure and record motor electrical values for voltage and amperage.
 - 3. Manually operate dampers from fully closed to fully open position and record fan performance.

3.06 ADJUSTING

- A. Adjust damper linkages for proper damper operation.
- B. Comply with requirements in Section 23 05 93 "Testing, Adjusting, and Balancing for HVAC" for air-handling system testing, adjusting, and balancing.

3.07 CLEANING

- A. After completing system installation and testing, adjusting, and balancing air-handling unit and air-distribution systems and after completing startup service, clean air-handling units internally to remove foreign material and construction dirt and dust. Clean fan wheels, cabinets, dampers, coils, and filter housings, and install new, clean filters.

3.08 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain air-handling units.

END OF SECTION 23 73 13

SECTION 23 81 26.13
DUCTLESS SPLIT-SYSTEM AIR-CONDITIONERS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00.
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) requirements.

1.03 SUMMARY

- A. Section Includes:
 - 1. Fan Coil Unit.
 - 2. Condensing unit.

1.04 REFERENCES

- A. Air-Conditioning and Refrigeration Institute:
 - 1. ARI 210/240 - Unitary Air-Conditioning and Air-Source Heat Pump Equipment.
 - 2. ARI 270 - Sound Rating of Outdoor Unitary Equipment.
 - 3. ARI 340/360 - Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment.
 - 4. ARI 365 - Commercial and Industrial Unitary Air-Conditioning Condensing Units.
- B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:
 - 1. ASHRAE 52.1 - Gravimetric and Dust-Spot Procedures for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter.
 - 2. ASHRAE 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings.
- C. ASTM International:
 - 1. ASTM B117 - Standard Practice for Operating Salt Spray (Fog) Apparatus.
- D. National Electrical Manufacturers Association:

1. NEMA MG 1 - Motors and Generators.

E. National Fire Protection Association:

1. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems.

1.05 SUBMITTALS

A. Product Data: Submit data indicating:

1. Cooling and heating capacities.

2. Dimensions.

3. Weights.

4. Rough-in connections and connection requirements.

5. Electrical requirements with electrical characteristics and connection requirements.

6. Controls.

7. Accessories.

B. Manufacturer's Installation Instructions: Submit assembly, support details, connection requirements, and include start-up instructions.

1.06 QUALITY ASSURANCE

A. Performance Requirements: Energy Efficiency Rating (SEER2) and Coefficient of Performance (COP) not less than prescribed by ASHRAE 90.1 when used in combination with compressors and evaporator coils when tested in accordance with ARI Standards.

PART 2 - PRODUCTS

2.01 SPLIT SYSTEM AIR CONDITIONING UNITS

A. Product Description: Split system consisting of fan coil unit and condensing unit including cabinet, evaporator fan, refrigerant cooling coil, compressor, refrigeration circuit, condenser, air filters, controls, air handling unit accessories, condensing unit accessories, and refrigeration specialties.

B. Manufacturers:

1. Daikin.

2. Mitsubishi.

3. Sanyo

C. Refrigerants R-32.

2.02 FAN COIL UNIT

A. Cabinet:

1. Panels: Constructed of galvanized steel with baked enamel finish. Access Panels: Located on both sides of unit. Furnish with duct collars on inlets and outlets.
2. Insulation: Factory applied to each surface to insulate entire cabinet. One inch thick neoprene coated aluminum foil faced glass fiber with edges protected from erosion.

B. Evaporator Fan: Forward curved centrifugal type, resiliently mounted with adjustable belt drive and high efficiency motor. Motor permanently lubricated with built-in thermal overload protection.

C. Evaporator Coil: Constructed of copper tubes expanded onto copper fins. Factory leak tested under water. Removable, PVC construction, double-sloped stainless steel drain pan with piping connections on both sides. Coil shall be coated with minimum 1.0 mil. aluminum impregnated polyurethane coating by Blygold PoluAl XT or approved equal. Coating shall withstand 4,000 hours in both salt spray test per ASTM B117 and acid salt spray test per ASTM D5339.

D. Refrigeration System: Single or Dual refrigeration circuits controlled by factory installed thermal expansion valve. Refrigerant shall be R32.

E. Air Filters: 1-inch-thick glass fiber disposable media in metal frames. 25 to 30 percent efficiency based on ASHRAE 52.1.

F. Unit shall be wall mounted, ceiling mounted, or ceiling cassette type (integral with grid).

2.03 CONDENSING UNIT

A. General: Factory assembled and tested air-cooled condensing units, consisting of casing, compressors, condensers, coils, condenser fans and motors, and unit controls.

B. Unit Casings: Exposed casing surfaces constructed of galvanized steel with manufacturer's standard baked enamel finish. Designed for outdoor installation and complete with weather protection for components and controls, and complete with removable panels for required access to compressors, controls, condenser fans, motors, and drives.

C. Compressor: Single refrigeration circuit or two independent refrigeration circuits with rotary or hermetic semi-hermetic reciprocating type compressors, resiliently mounted, with positive lubrication, and internal motor overload protection. Compressor shall have a five (5) year warranty.

D. Condenser Coil: Constructed of copper tubing mechanically bonded to copper fins, factory leak and pressure tested. Coil shall be coated with minimum 1.0 mil. aluminum impregnated polyurethane coating by Blygold PoluAl XT or approved equal. Coating shall

withstand 4,000 hours in both salt spray test per ASTM B117 and acid salt spray test per ASTM D5339.

- E. Controls: Furnish operating and safety controls including high and low pressure cutouts. Control transformer. Furnish magnetic contactors for compressor and condenser fan motors.
- F. Condenser Fans and Drives: Direct drive propeller fans statically and dynamically balanced. Wired to operate with compressor. Permanently lubricated ball bearing type motors with built-in thermal overload protection. Furnish high efficiency fan motors.
- G. Condensing Unit Accessories: Furnish the following accessories:
 - 1. Controls to provide low ambient cooling to 0 degrees F.
 - 2. Time delay relay.
 - 3. Anti-short cycle timer.
 - 4. Disconnect switch.
 - 5. Vibration isolators.
 - 6. Coil with corrosion resistant coating capable of withstanding salt spray test of 1000 hours in accordance with ASTM B117.
 - 7. Condenser Coil Guard: Condenser fan openings furnished with PVC coated steel wire safety guards.
 - 8. Suction and discharge pressure gauges.
- H. Refrigeration specialties: Furnish the following for each circuit:
 - 1. Charge of compressor oil.
 - 2. Holding charge of refrigerant.
 - 3. Replaceable core type filter drier.
 - 4. Liquid line sight glass and moisture indicator.
 - 5. Shut-off valves on suction and liquid piping.
 - 6. Liquid line solenoid valve.
 - 7. Charging valve.
 - 8. Oil level sight glass.
 - 9. Crankcase heater.
 - 10. Hot gas muffler.

11. Pressure relief device.

2.04 CONTROLS

A. Interface with BAS (Building Automation System).

PART 3 - EXECUTION

3.01 INSTALLATION – FAN COIL UNIT

A. Install per manufacturer's recommendations. Where appropriate, provide 2" deflection spring vibration isolators.

B. Install condensate piping with trap and route from drain pan to approved receptor.

3.02 TRAINING

A. Training shall include a minimum of 1-hour hands-on training.

END OF SECTION 23 81 26.13

SECTION 26 05 00
BASIC METHODS AND REQUIREMENTS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 specification sections, apply to work of this section.
- B. Furnish and install all electrical wiring, systems, equipment and accessories in accordance with the specifications and drawings. Capacities and ratings of motors, cable, panelboards, etc., and arrangement for specified items in general are shown on drawings.
- C. All ampacities herein specified or indicated on the drawings are based on copper conductors, with the conduit and raceways accordingly sized. Aluminum conductors are not permitted.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00.
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) requirements.

1.03 MINIMUM REQUIREMENTS

- A. References to the National Electrical Code (NEC), Underwriters Laboratories, Inc. (UL), Florida Building Code, and National Fire Protection Association (NFPA) are a minimum installation requirement standard. Design drawings and other specification sections shall govern in those instances where requirements are greater than those specified in NEC.
- B. The rules and regulations of the Federal, State, local, civil authorities and utility companies in force at the time of execution of the contract shall become a part of this specification. In addition, the following codes and standards shall apply:
 - 1. Florida Building Code (FBC) 8th Edition (2023): This code includes the 2023 FBC Building, Mechanical, Plumbing, Energy Conservation, Fuel Gas, Accessibility, and Test Protocols volumes. Further, see "Referenced Standards" in the FBC Building Chapter 35; FBC Mechanical Chapter 15; FBC Plumbing Chapter 15; FBC Energy Conservation Chapter 6; and FBC Fuel Gas Chapter 8) (Effective December 31, 2023).
 - 2. 8th Edition of the Florida Fire Prevention Code (FFPC): This code also includes the Florida versions of NFPA 1 and NFPA 101. (Effective December 31, 2023).
 - 3. 2020 National Electric Code.
- C. No work shall be done unless the Superintendent of the Contractor is on the job site. Work shall be properly protected, all rubbish removed promptly, and exposed work shall be carefully cleaned prior to final acceptance.

- D. The term "provide" shall include labor, materials, and equipment necessary to furnish and install, complete and operable, the item or system indicated.
- E. In decisions arising from discrepancies, interpretation of Drawings and Specifications, substitutes, and other pertinent matters, the decision of the Owner's representative's approval shall be final.

1.04 SPECIFICATIONS AND DRAWINGS

- A. Plans show location of fixtures and equipment and are intended to depict the general intent of the work in scope, layout and quality of workmanship. They are not intended to show in minute detail every or all accessories intended for the purpose of executing the work, but it is understood that such details are a part of this work.
- B. Where Drawings and Specifications conflict, it shall be the responsibility of this Contractor to bring such conflict to the attention of the Architect/Engineer for clarification. In general, the Architectural Drawings shall take precedence over the Mechanical Drawings with reference to building construction. All changes from the Drawings necessary to make the work conform with the building as constructed and to fit the work of other trades or to conform to the rules of authorities having jurisdiction, shall be made by the Contractor at his own expense.
- C. Keep a record of the locations of concealed work and of any field changes in Contract Drawings and Specifications for each trade and, upon completion of the job, supply "As-Built" Drawings and Specifications showing in pencil on sepia reproducible, any deviations from the original Drawings, indicating in the Specifications each manufacturer's name underlined or inserted whose product was used on the job. These Drawings shall indicate dimensions of buried utility lines from building walls. One set of sepia reproducible of the original tracings will be furnished upon request for this purpose.

1.05 STANDARDS

- A. All material and equipment shall be listed, labeled or certified by Underwriters Laboratories, Inc., where such standards have been established. Equipment and material which are not covered by UL Standards will be accepted provided equipment and material is listed, labeled, certified or otherwise determined to meet safety requirements of a nationally recognized testing laboratory. Equipment of a class which no nationally recognized testing laboratory accepts, certifies, lists, labels, or determines to be safe, will be considered if inspected or tested in accordance with national industrial standards, such as NEMA, or ANSI. Evidence of compliance shall include certified test reports and definitive shop drawings.
- B. Definitions:
 - 1. Listed: Equipment is "listed" if of a kind mentioned in a list which:
 - a. Is published by a nationally recognized laboratory which makes periodic inspection of production of such equipment.
 - b. States that such equipment meets nationally recognized standards or has been tested and found safe for use in a specified manner.
 - 2. Labeled: Equipment is labeled if:
 - a. It embodies a valid label, symbol, or other identifying mark of a nationally recognized testing laboratory such as Underwriters Laboratories, Inc.

- b. The laboratory makes periodic inspections of the production of such equipment.
 - c. The labeling indicates compliance with nationally recognized standards or tests to determine safe use in a specified manner.
3. Certified: Equipment is "certified" if:
 - a. Equipment has been tested and found by a nationally recognized testing laboratory to meet nationally recognized standards or to be safe for use in a specified manner.
 - b. Production is periodically inspected by a nationally recognized testing laboratory.
 - c. It bears a label, tag, or other record of certification.
4. Nationally recognized Testing Laboratory: A testing laboratory which is approved, in accordance with OSHA regulations, by the Secretary of Labor.

1.06 QUALIFICATIONS (PRODUCTS AND SERVICES)

- A. Manufacturers Qualifications: The manufacturer shall regularly and presently produce, as one of the manufacturer's principal products, the equipment and material specified for this project, and shall have manufactured the item for at least five years, unless otherwise noted elsewhere in the specifications or on the drawings.
- B. Product Qualification:
 1. Manufacturer's product shall have been in satisfactory operation on three installations of similar size and type, as this project, for approximately three years.
 2. The Owner reserves the right to require the contractor to submit a list of installations where the products have been in operation before approval of said products.
- C. Service Qualifications: There shall be a permanent service organization maintained or trained by the manufacturer which will render satisfactory service to this installation within four hours of receipt of notification that service is needed. Submit name and address of service organizations.

1.07 MANUFACTURED PRODUCTS

- A. Materials and equipment furnished shall be of current production by manufacturers regularly engaged in the manufacture of such items, for which replacement parts should be available. Items not meeting this requirement, but which otherwise meet technical specifications, and merits of which can be established through reliable test reports or physical examination of representative samples, will be considered.
- B. When more than one unit of the same class of equipment is required, such units shall be the product of a single manufacturer.
- C. Equipment Assemblies and Components:
 1. All components of an assembled unit need not be products of the same manufacturer, however, the assembled unit shall be the responsibility of a single manufacturer and warranted as such.

2. Manufacturers of equipment assemblies, which include components made by others, shall assume complete responsibility for the final assembled unit.
 3. Components shall be compatible with each other and with the total assembly for the intended service.
 4. Constituent parts which are similar shall be the product of a single manufacturer.
- D. All factory wiring shall be identified on the equipment being furnished and on all wiring diagrams.

1.08 EQUIPMENT REQUIREMENTS

- A. Equipment voltage ratings shall be in accordance with the requirements indicated on the drawings or as specified.
- B. Prior to bid, written approval shall be obtained by the Contractor for any equipment that differs from those specified on the drawings and specifications. The Contractor shall be prepared to submit samples of the equipment when requested at no cost to the Architect/Engineer.
1. The Contractor shall furnish drawings showing all installation details, shop drawings, technical data and other pertinent information as required to determine that the equipment is equivalent in quality and function to the equipment specified.
 2. Approval by the Architect/Engineer of the equal equipment does not relieve the Contractor of the responsibility of furnishing and installing the equipment at no additional cost to the Owner.
 3. Any other items required for the satisfactory installation of the equal equipment shall be furnished and installed at no additional cost to the Owner. This includes but shall not be limited to additions or changes to branch circuits, circuit protective devices, conduits, wire, feeders, controls, panels and correlation with other work, subject to the jurisdiction and approval of the Architect/Engineer.
- C. Catalogue numbers, where given, are intended to give a basis for design, quality and function. Any other incidental equipment needed for a complete and functional installation shall be provided at no additional cost.

1.09 EQUIPMENT PROTECTION

- A. Equipment and material shall be protected during shipment and storage against physical damage, dirt, moisture, cold and rain.
- B. During installation, equipment, controls, controllers, circuit protective devices, etc., shall be protected against entry of foreign matter; and be vacuum cleaned both inside and outside before testing, operating and painting.
- C. Damaged equipment shall be, as determined by the Architect/Engineer, placed in first class operating condition or be returned to the source of supply for repair or replacement.
- D. Painted surfaces shall be protected with factory installed removable heavy kraft paper, sheet vinyl or equal.

- F. Damaged paint on equipment and materials shall be refinished with the same quality of paint and workmanship as used by the manufacturer so repaired areas are not obvious.

1.10 WORK PERFORMANCE

- A. Arrange, phase and perform work to assure electrical service for other buildings at all times.
- B. New work shall be installed and connected to existing work neatly and carefully. Disturbed or damaged work shall be replaced or repaired to its prior conditions.
- C. Coordinate location of equipment and conduit with other trades to minimize interferences.
- D. Obtain and pay for all required installation inspections and deliver certificates approving installations to the Owner unless directed otherwise.

1.11 EQUIPMENT INSTALLATION AND REQUIREMENTS

- A. Equipment location shall be as close as practical to locations shown on the drawings. Where architectural features govern location of work, refer to architectural drawings.
- B. Working spaces shall not be less than specified in the National Electrical Code for all voltages specified.
- C. Inaccessible Equipment:
 - 1. Where the Owner/Architect/Engineer determines that the Contractor has installed equipment not conveniently accessible for operation and maintenance, equipment shall be removed and reinstalled as directed at no additional cost to the Owner.
 - 2. "Conveniently accessibility" is defined as being capable of being reached without the use of ladders, or without climbing or crawling under or over obstacles such as motors, pumps, belt guards, transformers, piping, and duct work.
- D. Equipment and Material:
 - 1. New equipment and material shall be installed, unless otherwise specified.
 - 2. Equipment and material shall be designed to assure satisfactory operation and operating life for environmental conditions where being installed. NEC and other code requirements shall apply to the installation in areas requiring special protection such as explosion-proof, watertight and weatherproof construction.
- E. Utility Services:
 - 1. Determine Gulf Power Company (GPC) connection requirements and include in the base bid all known costs to the Owner for utility service. Contact GPC, make any required application, schedule and coordinate GPC's work and equipment delivery in order to meet the project schedule and sequencing.
 - 2. Include all costs for temporary service, temporary routing of service or any other requirements of a temporary nature associated with the utility/main service.

3. Contact GPC specifically to coordinate the relocation of the existing underground primary lines that are routed through the existing site at this time.

F. Continuity of Service:

1. No service shall be interrupted or changed without permission from the Architect and the Owner. Written permission shall be obtained before any work is started.
2. When interruption of services is required, all persons concerned shall be notified and a prearranged time agreed upon.
3. Provide any required temporary power or communications circuits or extensions necessary to accommodate the phasing of construction in order to keep any existing services in operation during construction.

G. Concrete Work:

1. Provide all cast-in-place concrete shown on the documents unless noted otherwise. Concrete work shall conform to all applicable Division 2 and 3 specification sections.
2. Provide all anchor bolts, metal shapes and templates required to be cast in concrete or used to form concrete for support of electrical equipment.

1.12 EQUIPMENT IDENTIFICATION

- A. In addition to the requirements of the National Electrical Code, install an identification nameplate which will clearly indicate information required for use and maintenance of items such as switchboard, panelboards, cabinets, safety switches, separately enclosed circuit breakers, motor starters, communications systems cabinets, control devices and other significant equipment.
- B. Nameplates shall be laminated phenolic resin with engraved lettering, a minimum of 3/16-inch high. Nameplates that are furnished by manufacturer as a standard catalog item, or where other method of identification is herein specified, are exceptions. Hand written marker is not acceptable.
 1. Nameplates shall be red with white letters for all 480Y/277 volt equipment and black with white letters for all 208Y/120 volt equipment.

1.13 SUBMITTALS

- A. The Architect/Engineer's approval shall be obtained for all equipment and material before delivery to the job site. Delivery, storage or installation of equipment or material which has not had prior approval will not be permitted at the job site. Submittals shall be made for all equipment and systems as indicated in the respective specification section.
- B. All submittals shall include adequate descriptive literature, catalog cuts, shop drawings and other data necessary for the Architect/Engineer to ascertain that the proposed equipment and materials comply with specification and drawing requirements. Catalog cuts submitted for approval shall be legible and clearly identify equipment being submitted.
- C. Submittals for individual systems and equipment assemblies which consist of more than one item or component shall be made for the system or assembly as a whole. Partial

submittals will not be considered for approval. Submittals shall be submitted for all applicable products and materials specified in each individual section of these specifications.

D. Make submittals for the equipment and materials in accordance with the following:

1. Mark the submittals, "SUBMITTED UNDER SECTION_____".
2. Submittals shall be marked to show specification reference including the section and paragraph numbers.
3. The submittals shall include the following:
 - a. Information that confirms compliance with contract requirements. Include the manufacturer's name, model or catalog numbers, catalog information, technical data sheets, shop drawings, pictures, nameplate data and test reports as required. Provide any additional information specifically requested in the individual specification section or on the drawings.
 - b. Elementary and interconnection wiring diagrams for fire alarm, sound system, TV system and other communication systems and equipment assemblies. All terminal points and wiring shall be identified on wiring diagrams.
 - c. Parts list which shall include those replacement parts recommended by the equipment manufacturer, quantity of parts, current price and availability of each part.
4. Electronic PDF submittal files shall be named utilizing the specification number followed by a sequential number for the submittal made under the given specification number followed by "r#" if it is a resubmittal, and then followed by a brief description of the submitted item.
 - a. The description shall indicate the actual item submitted, shall not be general in nature, and does not have to be that of the specification section heading.
 - b. Using the example, "23 02 35-4r2 Differential Pressure Gauge"; 23 02 35 – Meters and Gauges is the relevant specification, the "4" shows it was the fourth submittal for specification section 23 02 35 02,"r2" shows it was the second resubmittal, and the description indicates what item is submitted.
 - c. Each specification item shall be submitted in a separate PDF file. PDF files with multiple specification items will be returned without review.
 - d. Each file shall have sufficient space allowance for the Architects and Engineer's review stamp(s).
 - e. Each file shall have the Constructions Managers review stamp(s) and indicate information required by specification 26 05 00.1.12.D.3 above.

E. Operation and Maintenance Manuals:

1. Maintenance manuals shall be complete and shall be furnished in a loose leaf binder or in the manufacturer's standard binder. Information shall be sufficient to enable a qualified technician to perform normal first line maintenance and repair. A parts list shall be included which shall include those replacement parts recommended by the equipment manufacturer, quantity of parts, current price and availability of each part.

2. Operation manuals shall be clear and concise and shall describe, in detail, the information required to properly operate the equipment specified. The manuals shall include complete catalog cuts and as-built wiring diagrams.
 3. Operation and maintenance manuals shall be submitted for approval prior to final close-out.
- F. In addition to the requirement of SUBMITTALS, the Owner reserves the right to request the manufacturer to arrange for the Owner's representative(s) to see typical active systems in operation, when there has been no prior experience with the manufacturer or the type of equipment being submitted.

1.14 CUTTING, PATCHING, EXCAVATION, BACKFILL, AND LAYOUT

- A. Provide openings and excavation required for the installation of the electrical work. Patch work and backfill as required. Finished work shall match the existing adjoining work.
- B. Verify all conditions affecting the work to be performed under this contract.
- C. Carefully verify measurements at the site, determine the exact location of chases and openings required. Provide sleeves, inserts, and hangers as required. No columns, beams, joists, building foundations nor any other structural building component shall be cut, drilled or disturbed in any way. Conflicts shall immediately be brought to the attention of the Architect/Engineer.
- D. All excavation on sites containing existing buildings and existing services, shall be done with hand shovel to avoid damage to existing services. Where hand shovel is not practical extreme caution shall be taken when performing excavation. The contractor will be responsible for locating any existing utilities and adjusting manhole locations and conduit routing as necessary. Any damage incurred by the Contractor shall be repaired by the Contractor in a manner approved by the Architect/Engineer at no cost to the Owner and with no extension of time limitation.

1.15 EXPERIENCE

- A. The Contractor performing this work shall be a licensed, reputable firm, regularly performing the type of work incorporated in this project and who also maintains, as part of the firm, a service department with qualified personnel who regularly perform this type of work. The Contractor shall, upon request, show evidence of at least two jobs of similar character and size installed within the preceding two years.

1.16 ELECTRICAL WORK FOR MECHANICAL SYSTEMS

- A. Factory installed starters, controllers, and control equipment mounted in manufactured mechanical equipment necessary for mechanical equipment operation shall be furnished under Division 23 Mechanical.
- B. Power wiring for motors and installation of starters shall be under Division 26 Electrical.
- C. Temperature, humidity, pressure and similar controls essential to the operation of mechanical systems, and wiring and conduit thereof, including interlock wiring, shall be under Division 23 of Specifications, installed in accordance with requirements of Division 26.

- D. Motors shall be furnished under Division 23 Mechanical of capacity required to operate equipment specified, but shall not be less than that specified.
- E. All low voltage (120V and under) temperature control wiring for Division 23 equipment shall be provided under by Division 23.
- F. Division 23 shall provide conduit when required for control wiring, installed in accordance with Division 26 requirements.

1.17 MOTORS

- A. All motors shall be furnished and installed under Division 23 Mechanical and shall be wired under Division 26 Electrical.

1.18 REMOVAL OF RUBBISH

- A. Contractor shall keep premises free from accumulations of waste material or rubbish caused by his employees or work. At completion of work, he shall remove all his tools, scaffolding, surplus materials, and rubbish from building and site. He shall leave premises and his work in a clean orderly condition acceptable to the Architect/Engineer.

1.19 QUIET OPERATION AND VIBRATION

- A. All equipment provided under this section shall operate under all conditions of load free of objectionable sound and vibration. Sound and vibration conditions considered objectionable shall be corrected in an approved manner.
- B. Vibration and sound control shall be by means of approved vibration eliminators or sound attenuators in a manner as specified and as recommended by the manufacturer.

1.20 CLEANING AND ADJUSTMENTS

- A. Upon completion of the work, Contractor shall clean and re-lamp all light fixtures, clean and identify all equipment, adjust and test all equipment and apparatus which he has installed and make certain such apparatus and mechanisms are in proper working order and ready to test.
- B. During construction protect all conduit and equipment from damage and dirt. Cap the open ends of all conduit and equipment.

1.21 STORAGE OF MATERIALS

- A. All materials stored on site shall be properly protected from injury or deterioration. Materials shall not be stored in contact with ground or floor.
- B. Do not remove manufacturer's packing materials until ready to install. Materials showing signs of corrosion, improper handling or storage shall be replaced at no cost to the Owner.
- C. Provide continuous protection for all equipment already installed.

1.22 WATERPROOFING

- A. Where any work pierces waterproofing including waterproof concrete, the method of installation shall be as approved by the Owner before the work is done.

- B. Provide all necessary sleeves, caulking and flashing required to make openings absolutely watertight. Waterproof flashing materials shall be compatible with base materials.

1.23 TESTS

- A. Contractor shall make all tests required to establish the adequacy, quality, safety, completed status and satisfactory operation of all systems to the satisfaction of the Architect/Engineer. Provide all instruments, labor and services necessary to conduct tests.
- B. All conductors for the building and site electrical services, all building feeders, plus any other circuit conductors 400 amp rated and up, shall be megger tested to test insulation and connection integrity prior to permanent energization.
 - 1. Cables 600 Volts or Less: Cables 600 volts or less in size #3/0 and larger shall be meggered using an industry standard “megger” with 1000V internal generating voltage. Readings shall be recorded and submitted to the Engineer for acceptance prior to energizing same. Values are less than 200 Mohms shall be automatic failure. Submit PDF file of tabulated megger test values for all cables identified by the feeder name (Panel or equipment tag). Tester shall be a Megger MIT200 Series tester, or equivalent with auto discharge ensures all circuits are safely discharged after testing. 1000 V insulation test range shall have a high voltage warning prior to test voltage being applied.
 - 2. Submit a table summarizing the results at substantial completion. The initial table can be informal, hand-written, but a typed and formatted table shall be submitted with the project closeout documents.
- C. Refer to all other electrical specification sections for required testing and documentation.

1.24 INSTRUCTIONS

- A. Fully instruct Owner's personnel in the care and operation of electrical systems, including all communications, sound and fire alarm systems and furnish a letter to the Architect/Engineer advising the particular person(s) who have received such instruction.

1.25 GUARANTEE

- A. Equipment shall be started, tested, adjusted, and placed in satisfactory operating condition. Furnish a letter addressed to the Architect/Engineer advising that the completed systems have been installed in accordance with the Plans and Specifications and that they are in proper operating condition. The Owner shall receive a written guarantee covering all defects in workmanship and material for a period of one year from date of final acceptance. Any defects appearing within this year period shall be repaired without additional cost to the Owner. See specific specification sections for additional warranty coverage requirements. The most stringent shall apply.

1.26 ACCEPTANCE

- A. Before requesting final inspection:
 - 1. Complete all work required. If any items are held in abeyance as incomplete for final inspection, list such items together with explanation for delay.

2. Submit statement that equipment is properly installed, adjusted, tested and operation is satisfactory.
 3. Certify in writing to the Architect/Engineer that the Owner's representative has been instructed as to the care and operation of the system and that catalog service and maintenance information has been turned over to the Architect/Engineer.
 4. Submit copy of written guarantee.
 5. Submit copy of other data as may be outlined in these specifications.
- B. Copies of the above data shall be submitted to the Architect/Engineer prior to requesting final inspection.

1.27 SINGULAR NUMBER

- A. Where any device or part of equipment is referred to in these specifications in the singular number (such as "the switch"), such reference shall be deemed to apply to as many such devices as are required to complete the installation as shown on the drawings.

1.28 MULTI-WIRE BRANCH CIRCUITS

- A. All multi-wire branch circuits shall comply with Article 210.4 National Electrical Code. Provide all required handle ties where applicable multi-wire branch circuits are indicated on the drawings and do not share a neutrals. **DO NOT SHARE NEUTRALS UNLESS THE CIRCUITS ARE SPECIFICALLY SHOWN AS ONE HOMERUN WITH A SHARED NEUTRAL.**

1.29 COMMISSIONING

- A. Commissioning will be required as part of this project. Provide all required materials and labor to assist the commissioning agent for the completion and acceptance of the project commissioning.

END OF SECTION 26 05 00

SECTION 26 05 19
LOW VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including Division 01, General and Supplementary Conditions and other related Specification sections, apply to work of this section.
- B. This section is a Division-26 section, and is part of each Division-21, 22, 23 section and 26,27,28 section making reference to electrical wires and cables specified herein.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00.
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) requirements.

103 DESCRIPTION OF WORK

- A. Extent of electrical wire and cable work is indicated by drawings and schedules.
- B. Types of electrical wire, cable, and connectors specified in this section includes the following:
 - 1. Building wires and cables rated 600 V and less.
 - 2. Connectors, splices, and terminations rated 600 V and less.
 - 3. Copper conductors.
 - 4. Fixture wires.
 - 5. Flexible cords and cables.
 - 6. Wirenut connectors.
- C. Applications of electrical wire, cable, and connectors required for project are as follows:
 - 1. For motor-branch circuits.
 - 2. For power distribution circuits
 - 3. For lighting circuits
 - 4. For appliance and equipment circuits

1.04 QUALITY ASSURANCE

- A. Manufacturers: Firms regularly engaged in manufacture of electrical wire and cable products of types, sizes, and ratings required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Installer's Qualifications: Firm with at least 3 years of successful installation experience with projects utilizing electrical wiring and cabling work similar to that required for this project.

- C. NEC Compliance: Comply with NEC requirements as applicable to construction, installation and color coding of electrical wires and cables.
- D. UL Compliance: Comply with applicable requirements of UL Std 83, "Thermoplastic-Insulated Wires and Cables", and Std 486A, "Wire Connectors and Soldering Lugs for Use with Copper Conductors".
- E. UL Compliance: Provide wiring/cablings and connector products which are UL-listed and labeled.
- F. NEMA/ICEA Compliance: Comply with NEMA/ICEA Std Pub/ No.'s WC 5, "Thermoplastic-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy", and WC-30, "Color Coding of Wires and Cables", pertaining to electrical power type wires and cables.
- G. IEEE Compliance: Comply with applicable requirements of IEEE Stds 82, "Test Procedures for Impulse Voltage Tests on Insulated Conductors", and Std 241, "IEEE Recommended Practice for Electric Power Systems in Commercial Buildings" pertaining to wiring systems.
- H. ASTM Compliance: Comply with applicable requirements of ASTM B1, 2, 3, 8, and D-753. Provide copper conductors with conductivity of not less than 98% at 20°C (68°F).

PART 2 - PRODUCTS

2.01 WIRES, CABLES, AND CONNECTORS

- A. General: Provide electrical wires, cables, and connectors of manufacturer's standard materials, as indicated by published product information; designed and constructed as recommended by manufacturer, for a complete installation, and for application indicated. Except as otherwise indicated, provide copper conductors with conductivity of not less than 98% at 20°C (68°F).
- B. Building Wires: Provide factory-fabricated wires of sizes, ampacity ratings, and materials for applications and services indicated. Where not indicated, provide proper wire selection as determined by Installer to comply with project's installation requirements, NEC and NEMA standards. Select from the following UL types, those wires with construction features which fulfill project requirements:
 1. Type THHN, THWN, THHW, XHHW, THHN/THWN: Unless otherwise indicated, all conductors for dry locations requiring a conductor temperature rating 75°C (167°F) or less. Insulation shall be flame retardant, moisture and heat resistant, thermoplastic. Conductor shall be annealed copper.
 2. Type THWN, THHW, XHHW, THHN/THWN: Unless otherwise indicated, all conductors for wet or dry locations requiring a conductor temperature rating of 75°C (167°F) or less. Insulation shall be flame retardant, moisture and heat resistant thermoplastic. Conductor shall be annealed copper.
 3. Type THHN, THHW, XHHW: Unless otherwise indicated, all conductors for dry locations requiring a conductor temperature rating of 90°C (194°F) or less. Insulation shall be flame retardant, moisture and heat resistant thermoplastic. Conductor shall be annealed copper.
 4. Type XHHW-2: Unless otherwise indicated, all conductors for wet locations requiring a conductor temperature rating of 90°C (194°F) or less. Insulation shall

- be flame retardant, moisture and heat resistant thermoplastic. Conductor shall be annealed copper.
5. Conductors for use at 600 volts or below shall be 600 volt rated. All conductors shall be stranded. Stranded conductors shall terminate in crimp type lugs.
 6. Motor circuit branch wiring and associated control wiring: Provide type THHN insulation in dry and damp locations. Provide type THHW insulation in wet locations. All motor wiring to be stranded copper.
 7. Wiring in fixture channels: Provide conductors with a 90°C temperature rating, type THHN or TFFN insulation.
- C. Cables: Provide UL-type factory-fabricated cables of sizes, ampacity ratings, and materials and jacketing/sheathing as indicated for services indicated. Where not indicated, provide proper selection as determined by Installer to comply with installation requirements, NEC and NEMA standards.
- D. Connectors:
1. General: Provide UL-type factory-fabricated, metal connectors of sizes, ampacity ratings, materials, types and classes for applications and for services indicated. Where not indicated, provide proper selection as determined by Installer to comply with project's installation requirements, NEC and NEMA standards. Select from the following, those types, classes, kinds, and styles of connectors to fulfill project requirements:
 - a. Type: Pressure.
 - b. Class: Insulated.
 - c. Kind: Copper (for Cu to Cu connection).
 - d. Style: Butt connection.
 - e. Style: Elbow connection.
 - f. Style: Combined "T" and straight connection.
 - g. Style: "T" connection.
 - h. Style: Split-bolt parallel connection.
 - i. Style: Tap connection.
 - j. Style: Pigtail connection.
 - k. Style: Wirenut connection.

PART 3 - EXECUTION

3.01 INSTALLATION OF WIRES AND CABLES

- A. General: Install electrical cables, wires, and wiring connectors as indicated, in compliance with applicable requirements of NEC, NEMA, UI, and NECA's "Standard of Installation", and in accordance with recognized industry practices.
- B. Coordinate wire/cable installation work including electrical raceway and equipment installation work, as necessary to properly interface installation of wires/cables with other work.
- C. Pull conductors simultaneously where more than one conductor is being installed in the same raceway.
- D. Use pulling compound or lubricant, where necessary; compound used must not deteriorate conductor or insulation.

- E. Use pulling means including, fish tape, cable, rope and basket weave or wire/cable grips which will not damage cables or raceway. Any cable damaged during installation shall be completely replaced.
- F. Keep conductor splices to minimum. No joints shall be made in conductor except at outlet boxes or splice boxes. Newly installed conductors shall not be spliced unless specifically noted on the drawings.
- G. Install splices and tapes which possess equivalent-or-better mechanical strength and insulation ratings than conductors being spliced.
- H. Use splice and tap connectors which are compatible with conductor material.
- I. Tighten electrical connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque tightening values. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Std 486A and B.
- J. At least eight inches (8") of slack wire shall be left in every outlet box whether it be in use, or left for future use.
- K. Color code wiring as follows:
 - 1. 120/208 volt, 3 phase, 4 wire: phase A-black, phase B-red, phase C-blue, neutral-white; ground conductor-green.
 - 2. 277/480 volt, 3 phase, 4 wire: phase A-brown, phase B-orange, phase C-yellow, neutral-gray; ground conductor-green.
- L. Wire and cable boxes and reels shall bear the date of manufacture and must not bear dates by more than one year preceding contract date.
- M. Minimum conductor sizes, except as specifically identified on the drawings, shall be as follows:
 - 1. No. 12 - Branch circuits of any kind, except as specified otherwise below or otherwise specified on the drawings.
 - 2. No. 14 - Signal systems, fire alarm system, unless specifically noted otherwise.
 - 3. No. 10 - Exit light circuits, emergency circuits, security lighting, security systems circuits and exterior light circuits.
 - 4. No. 10 – Circuits with homeruns with more than one circuit and dedicated neutrals.
 - 4. All 120 volt, 20 amp circuits shall be increased by at least one conductor size (including ground wire) for circuit exceeding 125 feet in length.

3.02 FIELD QUALITY CONTROL AND TESTING

- A. Prior to energization, test wires and cables for electrical continuity, phase rotation, and for short-circuits.
- B. All conductors for the main campus electrical services, all building feeders, plus all conductors 200 amp rated and up, shall be megger tested to test insulation and connection integrity prior to permanent energization.
 - 1. Cables 600 Volts or Less: Cables 600 volts or less in size #3/0 and larger shall be meggered using an industry standard “megger” with 1000V internal

generating voltage. Readings shall be recorded and submitted to the Architect-Engineer for acceptance prior to energizing same. Values are less than 200 Mohms shall be automatic failure. Submit 5 copies of tabulated megger test values for all cables identified by the feeder name (Panel or equipment tag). Tester shall be a Megger MIT200 Series tester, or equivalent with auto discharge ensures all circuits are safely discharged after testing. 1000 V insulation test range shall have a high voltage warning prior to test voltage being applied. Failed conductors shall be replaced and re-tested.

3.03 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Section 07 84 13 "Penetration Firestopping."

END OF SECTION 26 05 19

SECTION 26 05 26
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including Division 01, General and Supplementary Conditions and other related Specification sections, apply to work of this section.
- B. Division-26 Basic Electrical Materials and Methods section apply to work of this section.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00.
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) requirements.

1.03 SUMMARY - DESCRIPTION OF WORK

- A. Extent of grounding work is indicated by drawings and schedules. A ground ring shall be provided around the building and bonded to the service entrance grounding electrode system and building lightning protection system.
- B. Types of grounding specified in this section include the following:
 - 1. Solid grounding
- C. Applications of grounding work in this section including the following:
 - 1. Underground metal water piping
 - 2. Metal building frames
 - 3. Grounding electrodes
 - 4. Grounding rods
 - 5. Service equipment
 - 6. Enclosures
 - 7. Equipment

1.04 QUALITY ASSURANCE

- A. Manufacturers: Firms regularly engaged in manufacture of electrical connectors, terminals and fittings, of types and ratings required, and ancillary grounding materials, including stranded cable, copper braid and bus, ground rods and plate electrodes, whose products have been in satisfactory use in similar service for not less than 3 years.
- B. Installer: Qualified with at least 3 years of successful installation experience on projects with electrical grounding work similar to that required for project.

- C. NEC Compliance: Comply with NEC requirements as applicable to materials and installation of electrical grounding systems, associated equipment and wiring. Provide grounding products which are UL-listed and labeled.
- D. UL Compliance: Comply with applicable requirements of UL Standards Nos. 467 and 869 pertaining to electrical grounding and bonding.
- E. IEEE Compliance: Comply with applicable requirements of IEEE Standard 142 and 241 pertaining to electrical grounding.

1.05 SUBMITTALS

- A. Product Data: Submit manufacturer's data on grounding systems and accessories, including ground bars, ground rods, and ground test wells.
- B. Shop Drawings: Submit layout drawings of grounding systems and accessories including, but not limited to, ground wiring, copper braid and bus, ground rods, and plate electrodes.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with all of the contract documents, manufacturers offering products that meet the requirements of these specifications may be considered.

2.02 GROUNDING SYSTEMS

A. Materials and Components:

- 1. General: Except as otherwise indicated, provide electrical grounding systems indicated; with assembly of materials, including, but not limited to, cables/wires, connectors, terminals (solderless lugs), grounding rods/electrodes and plate electrodes, bonding jumper braid, surge arresters, and additional accessories needed for complete installation. Where more than one type unit meets indicated requirements, selection is Installer's option. Where materials or components are not indicated, provide products complying with NEC, UL, IEEE, and established industry standards for applications indicated.

B. CONDUCTORS

- 1. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.
- 2. Bare Copper Conductors:
 - a. Solid Conductors: ASTM B 3.
 - b. Stranded Conductors: ASTM B 8.
 - c. Tinned Conductors: ASTM B 33.
 - d. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.
 - e. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.

- f. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
 - g. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
- C. Grounding Bus: Predrilled rectangular bars of annealed copper, **1/4 by 4 inches** in cross section, with 9/32-inch holes spaced 1-1/8 inches apart. See grounding details for length. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600 V and shall be Lexan or PVC, impulse tested at 5000 V.
- D. Ground Rods: Solid copper or copper clad steel, minimum 3/4" dia. x 10'. Provide longer rods if necessary for required resistivity.
- E. Electrical Grounding Connection Accessories: Provide electrical insulating tape, heat-shrinkable insulating tubing, welding materials, bonding straps, as recommended by accessories manufacturers for type services indicated.
- F. Cadweld: Provide exothermic cadweld ground connections where indicated on the drawings or where otherwise required for solid and reliable ground connections. Cadweld shall be used for :
 - 1. All service entrance grounding and bonding
 - 2. All emergency power distribution grounding and bonding
 - 3. All ground conductor to ground rod connections and inside all ground test wells.
- G. Ground Inspection Test Well: Ground test wells shall be polymer type concrete with 10,000 pound traffic rated cover. EriTech T416B and T416C or similar. Provide size as required for location. Adjust test well locations to coordinate with other site utilities, pavement and landscaping. Locate test wells in non-traffic, non-paved areas when possible.

PART 3 - EXECUTION

3.01 INSPECTION

- A. Installer must examine areas and conditions under which electrical grounding connections are to be made and notify Contractor in writing of conditions detrimental to proper completion of work. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

3.02 INSTALLATION OF ELECTRICAL GROUNDING

- A. General: Install electrical grounding systems where shown, in accordance with applicable portions of NEC, with NECA's "Standard of Installation", and in accordance with recognized industry practices, to ensure that products comply with requirements and serve intended functions.
- B. Coordinate with other electrical work as necessary to interface installation of electrical grounding system work with other work.

- C. Install clamp-on connectors only on thoroughly cleaned metal contact surfaces, to ensure electrical conductivity and circuit integrity. Any clamp on type connectors shall be suitable for the connection type applied.
- D. All ground connections to water service entrance shall be installed to be exposed and visible for inspection at all times. Insulation shall not be installed over ground connections.
- E. A water pipe, by itself, is not an adequate grounding electrode and must be supplemented by dual grounding electrodes, a minimum of 8 feet apart, and effectively bonded together. The supplemental ground shall be per Code with the "Footing type electrode" required for new construction.
- F. All ground connections shall be made on surfaces which have been cleaned of all paint, dirt, oil, etc., so that connections are bare metal to bare metal contact. All ground connections shall be tight and shall be made with U.L. listed grounding devices, fittings, bushings, etc.
- G. Duplex receptacles of any amperage shall be grounding type and shall have a separate grounding contact. A separate jumper shall be installed between the grounding terminal on the device and the metallic box. The Contractor may provide U.L. listed self-grounding receptacles in lieu of providing the separate jumper.
- H. Single and duplex receptacles shall have all grounded metal mechanically bonded together. Pressure bonding only is not acceptable.
- I. Single and duplex receptacles will be installed with the grounding contacts down.
- J. In all cases where flexible metallic conduit, nonmetallic rigid conduit or liquid tight flexible conduit is used, a green wire ground conductor shall be used to provide ground continuity between the equipment of device and the conduit raceway system.
- K. Provide a separate green wire ground conductor for each branch circuit originating from each panelboard. This ground shall be used to ground the device or load fed, and shall be bonded to components of the raceway system, such as junction boxes, starter or disconnect switch enclosures, equipment cases, etc. The green wire ground conductor shall terminate in the panelboard at the green wire ground bus. Ground conductors for branch circuits shall be of size indicated in NEC, except minimum size ground conductor shall be No. 12 AWG.
- L. Each branch feeder originating at the switchboard(s) or main distribution panel shall have a green wire ground conductor originating at the ground bus in the switchboard and terminating at the green wire ground bus in the panelboard. This green wire ground conductor shall be of size indicated in NEC except in no instance smaller than No. 8 AWG.
- M. The green wire ground conductor is in addition to the neutral conductor and in no case shall the neutral conductor serve as the grounding means.
- N. Multiple conductors in a single lug not permitted. Each grounding conductor shall terminate in its own terminal lug.

- O. Submit certified test results indicated a maximum resistance to ground of 5 ohms at all test wells and other required test points. Results shall be provided on a site plan indicating all test well locations and the resulting resistance.

3.03 GROUNDING SEPARATELY DERIVED SYSTEMS

- A. Generator: Install grounding electrode(s) at the generator location. The electrode shall be connected to the equipment grounding conductor and to the frame of the generator. The transfer switches will be 4 pole, switched neutral type.

3.04 EQUIPMENT GROUNDING

- A. Install separate copper insulated equipment grounding conductors with all feeders and branch circuits.
- B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
 - 1. Feeders and branch circuits.
 - 2. Lighting circuits.
 - 3. Receptacle circuits.
 - 4. Single-phase motor and appliance branch circuits.
 - 5. Three-phase motor and appliance branch circuits.
 - 6. Flexible raceway runs.
 - 7. All cable tray above ceilings and under raised floor.
 - 8. Raised flooring metal supports.
- C. Metallic Fences: Comply with requirements of IEEE C2.
 - 1. Grounding Conductor: Bare copper, not less than No. 8 AWG.
 - 2. Gates: Shall be bonded to the grounding conductor with a flexible bonding jumper.
 - 3. Barbed Wire: Strands shall be bonded to the grounding conductor.

3.05 INSTALLATION

- A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- B. Ground Bonding Common with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.
- C. Ground Rods: Drive rods until tops are 2 inches below finished floor or final grade unless otherwise indicated.

1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
- D. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in Section 260543 "Underground Ducts and Raceways for Electrical Systems," and shall be at least 12 inches deep, with cover.
1. Test Wells: Install at least one test well for each service unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.
- E. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.
1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
 2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
 3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.
- F. Grounding and Bonding for Piping:
1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
 2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
 3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.
- G. Ground Ring: Install a grounding conductor, electrically connected to each building structure ground rod and to each **steel column**, extending around the perimeter of **building**.
1. Install copper conductor not less than **No. 2/0** AWG for ground ring and for taps to building steel.
 2. Bury ground ring not less than **24 inches** from building's foundation.
- H. Concrete-Encased Grounding Electrode (Ufer Ground): Fabricate according to NFPA 70; use a minimum of **20 feet** of bare copper conductor size as indicated on the drawings.
1. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building's grounding grid or to grounding electrode external to concrete.

- I. Bond all cable trays to the grounding system using a minimum #6 awg insulated copper conductor from the tray to a ground bar or structural steel. Bond a minimum of every 50 feet, or more often as required by the cable tray specifications.
- J. Bond all raised flooring metal support structure using a minimum #6 awg insulated copper conductor from the floor support to a ground bar or structural steel. Bond a minimum of every 50 feet, or more often as required by the flooring specifications.

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Provide a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- C. Tests and Inspections:
 - 1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
 - 2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
 - 3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, at ground test wells, and at individual ground rods. Make tests at ground rods before any conductors are connected.
 - a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
 - b. Perform tests by fall-of-potential method according to IEEE 81.
 - c. Prepare dimensioned Drawings locating each test well, ground rod and ground-rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.
- D. Grounding system will be considered defective if it does not pass tests and inspections. Replace grounding systems and re-test as necessary for an acceptable system.
- E. Prepare test and inspection reports.
- F. Report measured ground resistances that exceed 5 ohms.
- G. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect -Engineer promptly and include recommendations to reduce ground resistance.

END OF SECTION 26 05 26

SECTION 260 5 29
HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and other related Specification sections, apply to work of this section.
- B. This section is a Division-26 Basic Electrical Materials and Methods section, and is a part of each Division-26,27,28 section making reference to electrical supporting devices specified herein.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00.
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) requirements.

1.03 DESCRIPTION OF WORK

- A. Extent of supports, anchors, sleeves, and seals is indicated by drawings and schedules and/or specified in other Division-16 sections.
- B. Types of supports, anchors, sleeves, and seals specified in this section include the following:
 - 1. Clevis hangers
 - 2. C-clamps
 - 3. I-beam clamps
 - 4. One-hole conduit straps
 - 5. Round steel rods
 - 6. Lead expansion anchors
 - 7. Toggle bolts
 - 8. Wall and floor seals
- C. Supports, anchors, sleeves, and seals furnished as part of factory-fabricated equipment, are specified as part of that equipment assembly in other Division-26 sections.

1.04 QUALITY ASSURANCE

- A. Manufacturers: Firms regularly engaged in manufacture of supporting devices, of types, sizes, and ratings required, whose products have been in satisfactory use in similar service for not less than 3 years.
- B. NEC Compliance: Comply with NEC requirements as applicable to construction and installation of electrical supporting devices.

PART 2 - PRODUCTS

2.01 MANUFACTURED SUPPORTING DEVICES

- A. General: Provide supporting devices which comply with manufacturer's standard materials, design and construction in accordance with published product information, and as required for complete installation; and as herein specified. Where more than one type of supporting device meets indicated requirements, selection is Installer's option.
- B. Supports: Provide supporting devices of types, sizes, and materials indicated; and having the following construction features:
1. Clevis Hangers: For supporting 2" rigid metal conduit; galvanized steel; with 1/2" dia. hole for round steel rod; approximately 54 pounds per 100 units.
 2. Reducing Couplings: Steel rod reducing coupling, 1/2" x 5/8"; black steel; approximately 16 pounds per 100 units.
 3. C-Clamps: Black malleable iron; 1/2" rod size; approximately 70 pounds per 100 units.
 4. I-Beam Clamps: Black steel, 1-1/4" x 3/16" stock; 3/8" cross bolt; flange width 2"; approximately 52 pounds per 100 units.
 5. One-Hole Conduit Straps: For supporting 3/4" rigid metal conduit; galvanized steel; approximately 7 pounds per 100 units.
 6. Hexagon Nuts: For 1/2" rod size; galvanized steel; approximately 4 pounds per 100 units.
 7. Round Steel Rod: Black steel; 1/2" dia.; approximately 67 pounds per 100 feet.
 8. Offset Conduit Clamps: For supporting 2" rigid metal conduit; black steel; approximately 200 pounds per 100 units.
- C. Anchors: Provide anchors of types, sizes, and materials indicated, with the following construction features:
1. Lead Expansion Anchors: 1/2", approximately 38 pounds per 100 units.
 2. Toggle Bolts: Springhead; 3/16" x 4", approximately 5 pounds per 100 units.
- D. Sleeves and Seals: Provide sleeves and seals, of types, sizes, and materials indicated, with the following construction features:
1. Wall and Floor Seals: Provide factory-assembled watertight wall and floor seals, of types and sizes indicated; suitable for sealing around conduit, pipe, or buting passing through concrete floors and walls. Construct seals with steel sleeves, malleable iron body, neoprene sealing grommets and rings, metal pressure rings, pressure clamps, and cap screws.
- E. U-Channel Strut Systems: Provide U-channel strut system for supporting electrical equipment, 12-gage hot-dip galvanized steel, of types and sizes indicated; construct with 9/16" dia. holes, 8" o.c. on top surface, with standard finish, and with the following fittings which mate and match U-channel.
1. Fixture hangers
 2. Channel hangers
 3. Thinwall conduit clamps

4. Rigid conduit clamps
 5. Conduit hangers
 6. U-bolts
- F. Pipe Sleeves: Provide pipe sleeves of one of the following:
1. Sheet Metal: Fabricate from galvanized sheet metal; round tube closed with snaplock joint, welded spiral seams, or welded longitudinal joint. Fabricate sleeves from the following gage metal: 3" and smaller, 20-gage; 4" to 6", 16-gage; over 6", 14-gage.
 2. Steel Pipe: Fabricate from Schedule 40 galvanized steel pipe; remove burrs.
 3. Iron Pipe: Fabricate from cast-iron or ductile-iron pipe; remove burrs.
 4. Plastic Pipe: Fabricate from Schedule 80 PVC plastic pipe; remove burrs.
- G. Sleeve Seals: Provide sleeves for piping which penetrates foundation walls below grade, or exterior walls. Calk between sleeve and pipe with non-toxic, UL-classified calking material to ensure watertight seal.

2.02 AVAILABLE MANUFACTURERS

- A. Subject to compliance with all of the contract documents, manufacturers offering products that meet the requirements of these specifications may be considered.

PART 3 - EXECUTION

3.01 INSTALLATION OF SUPPORTING DEVICES

- A. Install hangers, anchors, sleeves, and seals as indicated, in accordance with manufacturer's written instructions and with recognized industry practices to insure supporting devices comply with requirements. Comply with requirements of NECA and NEC for installation of supporting devices.
- B. Coordinate with other electrical work, including raceway and wiring work, as necessary to interface installation of supporting devices with other work. Coordinate support locations with other structural and mechanical trades. Supports shall not be attached to mechanical or electrical piping, conduit, ductwork, ceiling grid system or any other non-structural member.
- C. Install hangers, supports, clamps, and attachments to support piping properly from building structure. Arrange for grouping of parallel runs of horizontal conduits to be supported together on trapeze type hangers where possible. Install supports with spacings indicated and in compliance with NEC requirements.

END OF SECTION 26 05 29

SECTION 26 05 33
RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including Division 01, General and Supplementary Conditions and other related specification sections, apply to work of this section.
- B. This section is a Division 26 Basic Electrical Materials and Methods section, and is part of each Division-26, 27 and 28 section making reference to electrical raceways specified herein, including.
 - 1. Section 26 0 543 "Underground Ducts and Raceways for Electrical Systems" for exterior ductbanks, manholes, and underground utility construction.
 - 2. Section 27 05 28 "Pathways for Communications Systems" for conduits, wireways, surface pathways, innerduct, boxes, faceplate adapters, enclosures, cabinets, and handholes serving communications systems.
 - 3. Section 28 05 28 "Pathways for Electronic Safety and Security" for conduits, surface pathways, innerduct, boxes, and faceplate adapters serving electronic safety and security.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00.
 - 1. Refer to "PART 2 – PRODUCTS" for all Buy America Build America Act (BABA) requirements.

1.03 DESCRIPTION OF WORK

- A. Extent of raceway work is indicated by drawings and schedules. Types of raceways specified in this section include the following:
 - 1. Electrical metallic tubing (EMT).
 - 2. Liquid tight flexible metal conduit.
 - 3. Rigid metal conduit.
 - 4. Flexible metal conduit.
 - 5. Rigid non-metallic conduit.

1.04 QUALITY ASSURANCE

- A. Manufacturers: Firms regularly engaged in manufacture of raceway systems of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Installer's Qualifications: Firm with at least 3 years of successful installation experience on projects with electrical raceway work similar to that required for this project.
- C. Codes and Standards:

1. NEMA Compliance: Comply with applicable requirements of NEMA Standards Publications pertaining to raceways.
2. UL Compliance and Labeling: Comply with applicable requirements of UL safety standards pertaining to electrical raceway systems. Provide raceway products and components which have been UL-listed and labeled.
3. NEC Compliance: Comply with applicable requirements of NEC pertaining to construction and installation of raceway systems.

1.05 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data, including specifications and installation instructions, for each type of raceway system required. Include data substantiating that materials comply with requirements.

PART 2 - PRODUCTS

2.01 METAL CONDUIT AND TUBING

- A. General: Provide metal conduit, tubing, and fittings of types, grades, sizes, and weights (wall thicknesses) for each service indicated.
- B. Rigid Steel Conduit: Provide rigid steel, zinc-coated, threaded type conforming to FS WW-C-581, ANSI C80.1 and UL 6.
- C. Rigid Metal Conduit Fittings: Cast malleable iron, galvanized or cadmium plated, conforming to FS W-F-408, ANSI C80.4.
 1. Use compression type fittings for connections.
 2. Use compression type fittings for other miscellaneous connections.
- D. Electrical Metallic Tubing (EMT): FS WW-C-563, ANSI C80.3 and UL 797.
- E. EMT Fittings: FS W-F-408, ANSI C80.4. Die cast or malleable iron.
 1. Use compression fittings for raintight connections.
 2. Use compression type for concrete type connections.
 3. Use compression type fittings for miscellaneous connections.
- F. Liquid-Tight Flexible Metal Conduit: Provide liquid-tight flexible metal conduit; construct of single strip, flexible, continuous, interlocked, and double-wrapped steel; galvanized inside and outside; coat with liquid-tight jacket of flexible polyvinyl chloride (PVC).
- G. Liquid-Tight Flexible Metal Conduit Fittings: FS W-F-406, Type 1, Class 3, Style G. Provide cadmium plated, malleable iron fittings with compression type steel ferrule and neoprene gasket sealing rings, with insulated, or non-insulated throat.
- H. Flexible Metal Conduit: FS WW-C-566 and UL 1. Formed from continuous length of spiral wound, interlocked zinc-coated strip steel.
- I. Flexible Metal Conduit Fittings: Provide conduit fittings for use with flexible steel conduit of threadless hinged clamp type.

1. Straight Terminal Connectors: One piece body, female end with clamp and deep slotted machine screw for securing conduit, and male threaded end provided with locknut.
2. 45o or 90o Terminal Angle Connectors: Two-piece body construction with removable upper section, female end with clamp and deep slotted machine screw for securing conduit, and male threaded end provided with locknut.

2.02 NONMETALLIC CONDUIT

- A. General: Provide nonmetallic conduit, ducts, and fittings of types, sizes, and weights for each service indicated. Where types and grades are not indicated, provide proper selection determined by Installer to fulfill wiring requirements which comply with provisions of NEC for raceways.
- B. Electrical Plastic Conduit:
 1. Heavy Wall Conduit: Schedule 40, 90 C, UL-rated, construct of polyvinyl chloride and conforming to NEMA TC-2, for direct burial, or normal above ground use, UL-listed and in conformity with NEC Article 347, ANSI C33.91.
- C. PVC Conduit and Tubing Fittings: NEMA TC 3, mate and match to conduit or tubing type and material.

2.03 MANUFACTURERS

- A. Subject to compliance with all of the contract documents, manufacturers offering products that meet the requirements of these specifications may be considered.

2.04 BOXES, ENCLOSURES, AND CABINETS

- A. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.
- B. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
- C. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, [ferrous alloy] [aluminum], Type FD, with gasketed cover.
- D. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.
- E. Metal Floor Boxes:
 1. Material: Cast metal.
 2. Type: Fully adjustable.
 3. Shape: Rectangular.
 4. Listing and Labeling: Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- F. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb. Outlet boxes designed for attachment of luminaires weighing more than 50 lb shall be listed and marked for the maximum allowable weight.
- G. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

- H. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum or galvanized, cast iron with gasketed cover.
- I. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
- J. Device Box Dimensions: 4 inches square by 2-1/8 inches deep.
- K. Gangable boxes are allowed.
- L. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1, Type 3R, or Type 12 with continuous-hinge cover with flush latch unless otherwise indicated.
 - 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
 - 2. Nonmetallic Enclosures: Fiberglass.
 - 3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.
- M. Cabinets:
 - 1. NEMA 250, Type 1, Type 3R, or Type 12 galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
 - 2. Hinged door in front cover with flush latch and concealed hinge.
 - 3. Key latch to match panelboards.
 - 4. Metal barriers to separate wiring of different systems and voltage.
 - 5. Accessory feet where required for freestanding equipment.
 - 6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

PART 3 - EXECUTION

3.01 INSPECTION

- A. Examine areas and conditions under which raceways are to be installed, and substrate which will support raceways. Notify Contractor in writing of conditions detrimental to proper completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.02 INSTALLATION OF RACEWAYS

- A. General: Install raceways as indicated; in accordance with manufacturer's written installation instructions, and in compliance with NEC, and NECA's "Standards of Installation". Install units plumb and level, and maintain manufacturer's recommended clearances.
- B. Coordinate with other work including wires/cables, boxes, and panel work, as necessary to interface installation of electrical raceways and components with other work.

3.03 INSTALLATION OF CONDUITS

- A. General: Install concealed conduits in new construction work, either in walls, slabs, or above hung ceilings. Run conduits concealed in existing work where practical or specifically indicated on the drawings..

1. Mechanically fasten together metal conduits, enclosures, and raceways for conductors to form continuous electrical conductor. Connect to electrical boxes, fittings, and cabinets to provide electrical continuity and firm mechanical assembly.
2. Avoid use of dissimilar metals throughout system to eliminate possibility of electrolysis. Where dissimilar metals are in contact, coat surfaces with corrosion inhibiting compound before assembling.
3. Install miscellaneous fittings such as reducers, chase nipples, 3-piece unions, split couplings, and plugs that have been specifically designed and manufactured for their particular application. Install expansion fittings in raceways every 200' linear run or wherever structural expansion joints are crossed.

B. Conduit Installation: Follow minimum requirements in all areas as follows:

1. Use rigid steel galvanized conduit in mechanical equipment rooms, the main electrical equipment rooms, where exposed to weather or subject to saturation with liquids. Also use rigid steel galvanized conduit for all underground conduit elbows, and risers from underground, except for conduits used for communications systems. Stub-ups into the generators shall be rigid galvanized steel.

All main service and feeder raceways above ground and exposed shall be rigid galvanized steel inside the main electrical room. Equipment is sized for top feed. **Bottom feed from underground will be permitted only if electrical equipment and electrical rooms can accommodate the space required including any required pull boxes.**

2. Use steel EMT above hung ceilings in offices, corridors, toilets, and lab areas, and above 18'-0" above the finished floor in spaces with exposed ceilings. Use EMT under raised floor areas.
3. Use galvanized rigid steel conduit or PVC heavy wall (Schedule 40) when raceways run below grade, under floors on grade or in concrete. All bends and elbows greater than 45 degrees shall be galvanized rigid steel conduit. All risers to cabinets and boxes when conduit is to be exposed shall be rigid steel conduit.
4. Conduit in walls to recessed panels and boxes shall be in accordance with NEC. PVC up to first point of termination with 4'-0" maximum in wall and EMT above 4'-0".
5. Use flexible conduit in movable partitions and from outlet boxes to lighting fixtures, and final 24" of connection to motors, control items or any equipment subject to movement or vibration, and in cells of precast concrete panels.
6. Use liquid-tight flexible conduit where subjected to one or more of the following conditions:
 - a. Exterior location.
 - b. Moist or humid atmosphere where condensate can be expected to accumulate.
 - c. Corrosive atmosphere.
 - d. Subjected to water spray or dripping oil, water, or grease.
7. Use hot-dipped galvanized conduit where conduit is routed outdoors or in anyway exposed to weather.
8. Contractor will be responsible for the following for all underground conduits:
 - a. Trenching and Excavation
 - b. Backfill
 - c. Compaction
9. MC cable shall not be permitted.

- C. Cut conduits straight, properly ream, and cut threads for heavy wall conduit deep and clean.
- D. Field bend conduit with benders designed for purpose so as not to distort nor vary internal diameter.
- E. Minimum conduit size shall be 1/2" unless noted otherwise. Homeruns shall be a minimum 3/4".
- F. Fasten conduit terminations in sheet metal enclosures by two (2) locknuts, and terminate with bushings. Install locknuts inside and out side enclosure.
- G. Conduits are not to cross pipe shafts, or ventilating duct openings.
- H. Keep conduits a minimum distance of 6" from parallel runs of flues, hot water pipes or other sources of heat. Wherever possible, install horizontal raceway runs above water and steam piping.
- I. Use of running threads at conduit joints and terminations is prohibited. Where required, use 3-piece union or split coupling.
- J. Complete installation of electrical raceways before starting installation of cables/wires within raceways.
- K. Install conduits so as not to damage or run through structural members. Avoid horizontal or cross runs in building partitions or side walls.
- L. Exposed Conduits:
 - 1. Install exposed conduits and extensions from concealed conduit systems neatly, parallel with, or at right angles to walls of building.
 - 2. Install exposed conduit work as not to interfere with ceiling inserts, sprinklers, lights or ventilation ducts or outlets.
 - 3. Support all conduits by use of hangers, clamps, or clips. Support conduits on each side of bends and on spacing not to exceed following: up to 1": 6'-0"; 1-1/4" and over: 8'-0". All conduits shall be adequately supported to prevent any noticeable deflection, vibration or rattle.
 - 4. Run conduits for outlets on waterproof walls exposed. Set anchors for supporting conduit on waterproof wall in waterproof cement.
- M. Conduit Fittings:
 - 1. Construct locknuts for securing conduit to metal enclosure with sharp edge for digging into metal, and ridged outside circumference for proper fastening.
 - 2. Bushings for terminating conduits smaller than 1- 1/4" are to have flared bottom and ribbed sides, with smooth upper edges to prevent injury to cable insulation.
 - 3. Install insulated type bushings for terminating conduits 1-1/4" and larger. Bushings are to have flared bottom and ribbed sides. Upper edge to have phenolic insulating ring molded into bushing.
 - 4. All bushings of standard or insulated type to have screw type grounding terminal.
 - 5. Miscellaneous fittings such as reducers, chase nipples, 3-piece unions, split couplings, and plugs to be specifically designed for their particular application.
- N. Concealed Conduits:

1. Metallic raceways installed underground or in floors below grade, or outside are to have conduit threads painted with corrosion inhibiting compound before couplings are assembled. Draw up coupling and conduit sufficiently tight to ensure watertightness.
 2. Conduit in concrete slabs: Separate conduits by not less than diameter of largest conduit to ensure proper concrete bond. Conduits must have a minimum of three-quarter inch (3/4") concrete cover.
 3. Embedded conduit diameter is not to exceed one-third (1/3) of slab thickness. Conduit shall not be run in slabs less than 3 inches thick.
- O. Underground Duct Banks and Underground Conduits: All underground conduits shall be installed per the National Electrical Code, in accordance with standard industry practices and in accordance with other sections of these specifications. Conduits in duct banks shall be neatly and securely installed in straight lines with manufactured elbows used for all turns and bends. Provide all required trenching, excavation, backfill, compaction, supports, manholes, etc. for a complete installation. Trenching, excavation, backfill and compaction shall be performed in accordance with applicable civil/site engineering sections of these specifications.
- P. Low Voltage Control:
1. Contractor (Division 21,22,23) to provide and install all necessary wire and raceway (EMT conduit) for low voltage control such as thermostats, timers etc., unless specifically shown otherwise on the drawings. Raceways shall be installed in accordance with Division 26 sections. Final wire connections shall be by contractor.

3.04 INSTALLATION OF RACEWAYS AND WIREWAYS

- A. General: Mechanically assemble metal enclosures, and raceways for conductors to form continuous electrical conductor, and connect to electrical boxes, fittings and cabinets as to provide effective electrical continuity and rigid mechanical assembly.
1. Avoid use of dissimilar metals throughout system to eliminate possibility of electrolysis. Where dissimilar metals are in contact, coat all surfaces with corrosion inhibiting compound before assembling.
 2. Install expansion fittings in all raceways wherever structural expansion joints are crossed.
 3. Make changes in direction of raceway run with proper fittings, supplied by raceway manufacturer. No field bends of raceway sections will be permitted.
 4. Properly support and anchor raceways for their entire length by structural materials. Raceways are not to span any space unsupported. Supporting conduits from ceiling grid, other conduits, ductwork or other non-structural members will not be permitted.
 5. Use boxes as supplied by raceway manufacturer wherever junction, pull or devices boxes are required. Standard electrical "handy" boxes, etc. shall not be permitted for use with surface raceway installations.

3.05 COMMUNICATIONS SYSTEMS RACEWAY

- A. Communications systems raceways shall be provided for each fire alarm outlet or device indicated on the drawings. Conduit shall be as indicated on the drawings and in the separate specification section for each system.

- B. Communications systems raceways for IT/data network, AV, security, access controls, and cameras shall be provided as described in the IT documents prepared by Half & Associates. Refer to those documents for requirements.

END OF SECTION 26 05 33

SECTION 26 05 43
UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00.
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) requirements.

1.03 SUMMARY

- A. Section Includes:
 - 1. Direct-buried conduit, ducts, and duct accessories.
 - 2. Handholes and boxes.

1.04 DEFINITIONS

- A. Trafficways: Locations where vehicular or pedestrian traffic is a normal course of events.

1.05 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include duct-bank materials, including separators and miscellaneous components.
 - 2. Include ducts and conduits and their accessories, including elbows, end bells, bends, fittings, and solvent cement.
 - 3. Include accessories for manholes, handholes, boxes.
 - 4. Include warning tape.
- B. Shop Drawings:
 - 1. Precast or Factory-Fabricated Underground Utility Structures:
 - a. Include plans, elevations, sections, details, attachments to other work, and accessories.
 - b. Include duct entry provisions, including locations and duct sizes.
 - c. Include reinforcement details.
 - d. Include frame and cover design and manhole frame support rings.
 - e. Include grounding details.
 - f. Include dimensioned locations of cable rack inserts, pulling-in and lifting irons, and sumps.
 - g. Include joint details.
 - 2. Factory-Fabricated Handholes and Boxes Other Than Precast Concrete:

- a. Include dimensioned plans, sections, and elevations, and fabrication and installation details.
- b. Include duct entry provisions, including locations and duct sizes.
- c. Include cover design.
- d. Include grounding details.
- e. Include dimensioned locations of cable rack inserts, and pulling-in and lifting irons.

1.06 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.

1.07 FIELD CONDITIONS

- A. Ground Water: Assume ground-water level is at grade level unless a lower water table is noted on Drawings.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS FOR DUCTS AND RACEWAYS

- A. Comply with ANSI C2.

2.02 CONDUIT

- A. Rigid Steel Conduit: Galvanized. Comply with ANSI C80.1.
- B. RNC: NEMA TC 2, Type EPC-40-PVC and Type EPC-80-PVC, UL 651, with matching fittings by same manufacturer as the conduit, complying with NEMA TC 3 and UL 514B.

2.03 NONMETALLIC DUCTS AND DUCT ACCESSORIES

- A. Underground Plastic Utilities Duct: NEMA TC 2, UL 651, ASTM F 512, Type EPC-40, with matching fittings complying with NEMA TC 3 by same manufacturer as the duct.
- B. Solvents and Adhesives: As recommended by conduit manufacturer.
- C. Duct Accessories:
 - 1. Duct Separators: Factory-fabricated rigid PVC interlocking spacers, sized for type and size of ducts with which used, and selected to provide minimum duct spacing indicated while supporting ducts during concreting or backfilling.
 - 2. Warning Tape: Underground-line warning tape shall be yellow nylon with metallic locator strip.

2.04 PRECAST CONCRETE HANDHOLES AND BOXES

- B. Comply with ASTM C 858 for design and manufacturing processes.
- C. Description: Factory-fabricated, reinforced-concrete, monolithically poured walls and bottom unless open-bottom enclosures are indicated. Frame and cover shall form top of enclosure and shall have load rating consistent with that of handhole or box.

1. Frame and Cover: Weatherproof steel frame, with steel cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.
2. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
3. Cover Legend: Molded lettering, "ELECTRIC.", or "COMM"
4. Configuration: Units shall be designed for flush burial and have open bottom unless otherwise indicated.
5. Extensions and Slabs: Designed to mate with bottom of enclosure. Same material as enclosure.
 - a. Extension shall provide increased depth of 12 inches.
 - b. Slab: Same dimensions as bottom of enclosure, and arranged to provide closure.
6. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.
Retain one of or both "Windows" and "Duct Entrances in Handhole Walls" subparagraphs below to specify provisions to be made in the factory to accommodate connections of ducts to handholes in the field. Coordinate with Drawings.
Retain "Windows" Subparagraph below to require window openings in handhole walls, arranged so duct banks and their terminating fittings can be cast in place in the field after handholes are installed. This method can minimize problems of aligning duct banks with handhole openings in the field.
10. Windows: Precast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks, plus an additional 12 inches vertically and horizontally to accommodate alignment variations.
 - a. Windows shall be located no less than 6 inches from interior surfaces of walls, floors, or frames and covers of handholes, but close enough to corners to facilitate racking of cables on walls.
 - b. Window opening shall have cast-in-place, welded-wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct banks.
 - c. Window openings shall be framed with at least two additional No. 3 steel reinforcing bars in concrete around each opening.
 Retain "Duct Entrances in Handhole Walls" Subparagraph below to require end-bell or duct-terminating fittings to be factory installed, ready for connection to approaching ducts in the field. This method reduces installation costs but may increase risk of potential alignment problems.
11. Duct Entrances in Handhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.
 - a. Type and size shall match fittings to duct or conduit to be terminated.
 - b. Fittings shall align with elevations of approaching ducts and be located near interior corners of handholes to facilitate racking of cable.
12. Handholes 36 inches wide by 36 inches long and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.

2.05 HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

- A. General Requirements for Handholes and Boxes: Comply with SCTE 77. Comply with tier requirements in "Underground Enclosure Application" Article.
 1. Color: Gray.
First option in "Configuration" Subparagraph below facilitates bottom duct entry. Second option may be provided by a separate slab placed in the excavation under an open-bottom enclosure; third option is obtained by molding or fabricating the bottom integrally with the body of the unit.

2. Configuration: Units shall be designed for flush burial and have open bottom unless otherwise indicated.
 3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
 4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
 5. Cover Legend: Molded lettering, "ELECTRIC.", or "COMM"
Consider retaining "Direct-Buried Wiring Entrance Provisions" Subparagraph below if wires or cables are direct buried and enter enclosure through side. Otherwise, entry shall be made through an open bottom or through side openings cut in the field as specified in Part 3. Coordinate with Drawings.
 6. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.
Retain "Duct Entrance Provisions" Subparagraph below if ducts enter enclosure through side. Otherwise, entry shall be made through an open bottom or through side openings cut in the field. Coordinate with Drawings.
 7. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
 8. Handholes 36 inches wide by 36 inches long and larger shall have factory-installed inserts for cable racks and pulling-in irons.
- B. Polymer Concrete Handholes and Boxes with Polymer Concrete Cover: 24" x 24" or smaller may be molded of sand and aggregate, bound together with a polymer resin, and reinforced with steel or fiberglass or a combination of the two.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Coordinate layout and installation of ducts, manholes, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field. Notify Architect-Engineer if there is a conflict between areas of excavation and existing structures or archaeological sites to remain.
- B. Coordinate elevations of ducts and duct-bank entrances into manholes, handholes, and boxes with final locations and profiles of ducts and duct banks, as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations as required to suit field conditions and to ensure that duct runs drain to manholes and handholes, and as approved by Architect-Engineer.
- C. Clear and grub vegetation to be removed, and protect vegetation to remain according to Section 31 10 00 "Site Clearing." Remove and stockpile topsoil for reapplication according to Section 31 10 00 "Site Clearing."

3.02 UNDERGROUND DUCT APPLICATION

- A. See the Underground Raceway Application Chart and "Underground Duct Installation Considerations Article in the Evaluations. Coordinate with products listed in "Nonmetallic Ducts and Duct Accessories" Article.
- B. Ducts for Electrical Feeders 600 V and Less: RNC, NEMA Type EPC-80 PVC, in direct-buried duct bank unless otherwise indicated.

- C. Ducts for Electrical Branch Circuits: RNC, NEMA Type EPC-40-PVC, in direct-buried duct bank unless otherwise indicated.

3.03 UNDERGROUND ENCLOSURE APPLICATION

- A. Handholes and Boxes for 600 V and Less:
 - 1. Units in Roadways and Other Deliberate Traffic Paths: Precast concrete. AASHTO HB 17, H-20 structural load rating.
 - 2. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Precast concrete, AASHTO HB 17, H-20, Polymer concrete, SCTE 77, Tier 15, Fiberglass-reinforced polyester resin, SCTE 77, Tier 15 structural load rating.
 - 3. Units in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: Precast concrete, AASHTO HB 17, H-10, Polymer concrete units, SCTE 77, Tier 8, Heavy-duty fiberglass units with polymer concrete frame and cover, SCTE 77, Tier 8 structural load rating.
 - 4. Units Subject to Light-Duty Pedestrian Traffic Only: Fiberglass-reinforced polyester resin, structurally tested according to SCTE 77 with 3000-lbf (13 345-N) vertical loading.
 - 5. Cover design load shall not exceed the design load of the handhole or box.

3.04 EARTHWORK

- A. Excavation and Backfill: Comply with Section 31 20 00 "Earth Moving," but do not use heavy-duty, hydraulic-operated, compaction equipment.
- B. Retain three paragraphs below if Project requires restoration of disturbed features and areas.
- C. Restore surface features at areas disturbed by excavation, and re-establish original grades unless otherwise indicated. Replace removed sod immediately after backfilling is completed.
- D. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Section 32 92 00 "Turf and Grasses" and Section 32 93 00 "Plants."
- E. Cut and patch existing pavement in the path of underground ducts and utility structures according to the "Cutting and Patching" Article in Section 01 73 00 "Execution."

3.05 DUCT INSTALLATION

- A. Install ducts according to NEMA TCB 2.
- B. Slope: Pitch ducts a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope ducts from a high point in runs between two manholes, to drain in both directions.

- C. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 48 inches, both horizontally and vertically, at other locations unless otherwise indicated.
- D. Joints: Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in same plane.
- E. Installation Adjacent to High-Temperature Steam Lines: Where duct banks are installed parallel to underground steam lines, perform calculations showing the duct bank will not be subject to environmental temperatures above 40 deg C. Where environmental temperatures are calculated to rise above 40 deg C, and anywhere the duct bank crosses above an underground steam line, install insulation blankets listed for direct burial to isolate the duct bank from the steam line.
- F. Duct Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately 10 inches o.c. for 5-inch ducts, and vary proportionately for other duct sizes.
 - 1. Begin change from regular spacing to end-bell spacing 10 feet (3 m) from the end bell without reducing duct line slope and without forming a trap in the line.
 - 2. Direct-Buried Duct Banks: Install an expansion and deflection fitting in each conduit in the area of disturbed earth adjacent to manhole or handhole. Install an expansion fitting near the center of all straight line direct-buried duct banks with calculated expansion of more than 3/4 inch (19 mm).
 - 3. Grout end bells into structure walls from both sides to provide watertight entrances.
- G. Building Wall Penetrations: Make a transition from underground duct to rigid steel conduit at least 10 feet (3 m) outside the building wall, without reducing duct line slope away from the building, and without forming a trap in the line. Use fittings manufactured for duct-to-conduit transition. Install conduit penetrations of building walls as specified in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."
- H. Sealing: Provide temporary closure at terminations of ducts that have cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psig (1.03-MPa) hydrostatic pressure.
- I. Pulling Cord: Install 100-lbf- (445-N-) test nylon cord in empty ducts.
- J. Direct-Buried Duct Banks:
 - 1. Excavate trench bottom to provide firm and uniform support for duct bank. Comply with requirements in Section 312000 "Earth Moving" for preparation of trench bottoms for pipes less than 6 inches in nominal diameter.
 - 2. Support ducts on duct separators coordinated with duct size, duct spacing, and outdoor temperature.
 - 3. Space separators close enough to prevent sagging and deforming of ducts, with not less than [four] [five] spacers per 20 feet of duct. Secure separators to earth and to ducts to prevent displacement during backfill and yet permit linear duct

movement due to expansion and contraction as temperature changes. Stagger spacers approximately 6 inches between tiers.

4. Depth: Install top of duct bank at least 36 inches below finished grade unless otherwise indicated.
 5. Set elevation of bottom of duct bank below frost line.
 6. Install ducts with a minimum of 3 inches between ducts for like services and 6 inches between power and signal ducts.
 7. Elbows: Install manufactured duct elbows for stub-ups at poles and equipment, at building entrances through floor, and at changes of direction in duct run unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.
 8. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment, at building entrances through floor, and at changes of direction in duct run.
 - a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete.
 - b. For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.
 9. After installing first tier of ducts, backfill and compact. Start at tie-in point and work toward end of duct run, leaving ducts at end of run free to move with expansion and contraction as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand place backfill to 4 inches over ducts and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction. Comply with requirements in Section 31 20 00 "Earth Moving" for installation of backfill materials.
 - a. Place minimum 3 inches of sand as a bed for duct bank. Place sand to a minimum of 6 inches above top level of duct bank.
- K. Warning Tape: Bury warning tape approximately 12 inches above all concrete-encased ducts and duct banks. Align tape parallel to and within 3 inches of centerline of duct bank. Provide an additional warning tape for each 12-inch increment of duct-bank width over a nominal 18 inches. Space additional tapes 12 inches apart, horizontally.

3.06 INSTALLATION OF CONCRETE MANHOLES, HANDHOLES, AND BOXES

- L. Precast Concrete Handhole and Manhole Installation:
1. Comply with ASTM C 891 unless otherwise indicated.
 2. Install units level and plumb and with orientation and depth coordinated with connecting ducts, to minimize bends and deflections required for proper entrances.

3. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1-inch (25-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.

M. Elevations:

1. Manhole Roof: Install with rooftop at least 15 inches below finished grade.
2. Manhole Frame: In paved areas and trafficways, set frames flush with finished grade. Set other manhole frames 1 inch above finished grade.
3. Handhole Covers: In paved areas and trafficways, set surface flush with finished grade. Set covers of other handholes 1 inch above finished grade.
4. Where indicated, cast handhole cover frame integrally with handhole structure.

3.07 INSTALLATION OF HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

- A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting ducts, to minimize bends and deflections required for proper entrances. Use box extension if required to match depths of ducts, and seal joint between box and extension as recommended by manufacturer.
- B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch (12.5-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.
- C. Elevation: In paved areas and trafficways, set cover flush with finished grade. Set covers of other handholes 1 inch (25 mm) above finished grade.
- D. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in enclosure.
- E. Field cut openings for ducts and conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.
- F. For enclosures installed in asphalt paving or sod and subject to occasional, nondeliberate, heavy-vehicle loading, form and pour a concrete ring encircling, and in contact with, enclosure and with top surface screeded to top of box cover frame. Bottom of ring shall rest on compacted earth.
 1. Concrete: 3000 psi (20 kPa), 28-day strength, complying with Section 03 30 00 "Cast-in-Place Concrete," with a troweled finish.
 2. Dimensions: 6 inches wide by 12 inches deep.

3.08 GROUNDING

- A. Ground underground ducts and utility structures according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."

3.09 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections and prepare test reports:
 - 1. Demonstrate capability and compliance with requirements on completion of installation of underground ducts and utility structures.
 - 2. Pull solid aluminum or wood test mandrel through duct to prove joint integrity and adequate bend radii, and test for out-of-round duct. Provide a minimum 6-inch- (150-mm-) long mandrel equal to 80 percent fill of duct. If obstructions are indicated, remove obstructions and retest.
 - 3. Test handhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Section 26 05 26 “Grounding and Bonding for Electrical Systems.”
- B. Correct deficiencies and retest as specified above to demonstrate compliance.

3.10 CLEANING

- A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.
- B. Clean internal surfaces of manholes, including sump. Remove foreign material.

END OF SECTION 26 05 43

SECTION 26 05 44
SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00.
 - 1. Refer to "PART 2 – PRODUCTS" for all Buy America Build America Act (BABA) requirements.

1.03 SUMMARY

- A. Section Includes:
 - 1. Sleeves for raceway and cable penetration of non-fire-rated construction walls and floors.
 - 2. Sleeve-seal systems.
 - 3. Sleeve-seal fittings.
 - 4. Grout.
 - 5. Silicone sealants.
- B. Related Requirements:
 - 1. Section 07 84 13 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.01 SLEEVES

- A. Wall Sleeves:
 - 1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
 - 2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

- B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.
- C. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.
- D. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.
- E. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.
- F. Sleeves for Rectangular Openings:
 - 1. Material: Galvanized sheet steel.
 - 2. Minimum Metal Thickness:
 - a. For sleeve cross-section rectangle perimeter less than 50 inches and with no side larger than 16 inches, thickness shall be 0.052 inch.
 - b. For sleeve cross-section rectangle perimeter 50 inches or more and one or more sides larger than 16 inches, thickness shall be 0.138 inch.

2.02 SLEEVE-SEAL SYSTEMS

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
 - 1. Sealing Elements: EPDM, Nitrile, or Buna N 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, Stainless steel.
 - 3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, Stainless steel of length required to secure pressure plates to sealing elements.

2.03 SLEEVE-SEAL FITTINGS

- A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.

2.04 GROUT

- A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.
- B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- C. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

2.05 SILICONE SEALANTS

- A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.
 - 1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.
- B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

PART 3 - EXECUTION

3.01 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

- A. Comply with NECA 1.
- B. Comply with NEMA VE 2 for cable tray and cable penetrations.
- C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:
 - 1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
 - a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."
 - b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.
 - 2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
 - 3. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed.
 - 4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
- D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:
 - 1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
 - 2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.
- E. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

- F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- G. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing sleeve-seal system.

3.02 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.
- B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.03 SLEEVE-SEAL-FITTING INSTALLATION

- A. Install sleeve-seal fittings in new walls and slabs as they are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.
- C. Secure nailing flanges to concrete forms.
- D. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION 26 05 44

SECTION 26 05 53
IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and other related Specification sections, apply to work of this section.
- B. Division-26 Basic Electrical Materials and Methods section apply to work specified in this section.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00.
 - 1. Refer to "PART 2 – PRODUCTS" for all Buy America Build America Act (BABA) requirements.

1.03 DESCRIPTION OF WORK

- A. Extent of electrical identification work is indicated by drawings and schedules.
- B. Types of electrical identification work specified in this section include the following:
 - 1. Electrical power, control, and communication conductors.
 - 2. Operational instructions and warnings.
 - 3. Equipment/system identification signs.

1.04 QUALITY ASSURANCE

- A. Manufacturers: Firms regularly engaged in manufacture of electrical identification products of types required, whose products have been in satisfactory use in similar service for not less than 3 years.
- B. NEC Compliance: Comply with NEC as applicable to installation of identifying labels and markers for wiring and equipment.
- C. UL Compliance: Comply with applicable requirements of UL Std 969, "Marking and Labeling Systems", pertaining to electrical identification systems.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with all of the contract documents, manufacturers offering products that meet the requirements of these specifications may be considered.

2.02 ELECTRICAL IDENTIFICATION MATERIALS

- A. General: Except as otherwise indicated, provide manufacturer's standard products of categories and types required for each application. Where more than single type is specified for an application, selection is Installer's option, but provide single selection for each application.
 - 1. All receptacle coverplates shall be provided with permanent engraved labeling. Refer to wiring devices and drawings for more requirements. Stickers or tape will not be accepted.

2.03 ENGRAVED PLASTIC-LAMINATE SIGNS

- A. General: Provide engraving stock melamine plastic laminate, complying with FS L-P-387, in sizes and thicknesses indicated, engraved with engraver's standard letter style of sizes and wording indicated, white face and black core plies (letter color) except as otherwise indicated, punched for mechanical fastening except where adhesive mounting is necessary because of substrate.
 - 1. Thickness: 1/8", except as otherwise indicated.
 - 2. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate substrate.

2.04 LETTERING AND GRAPHICS

- A. General: Coordinate names, abbreviations and other designations used in electrical identification work, with corresponding designations shown, specified or scheduled. Provide numbers, lettering, and wording as indicated or, if not otherwise indicated, as recommended by manufacturer or as required for proper identification and operation/maintenance of electrical systems and equipment.

PART 3 - EXECUTION

3.01 APPLICATION AND INSTALLATION

- A. General Installation Requirements:
 - 1. Install electrical identification products as indicated, in accordance with manufacturer's written instructions and requirements of NEC.
 - 2. Coordination: Where identification is to be applied to surfaces which require finish, install identification after completion of painting.
 - 3. Regulations: Comply with governing regulations and requests of governing authorities for identification of electrical work.

3.02 OPERATIONAL IDENTIFICATION AND WARNINGS

- A. General: Wherever reasonably required to ensure safe and efficient operation and maintenance of electrical systems, and electrically connected mechanical systems and general systems and equipment, including prevention of misuse of electrical facilities by unauthorized personnel, install self-adhesive plastic signs or similar equivalent identification, instruction or warnings on switches, outlets and other controls, devices and doors of electrical enclosures. Where detailed instructions or explanations are needed, provide plasticized tags with clearly written messages adequate for intended purposes.

3.03 EQUIPMENT/SYSTEM IDENTIFICATION

- A. General: Install engraved plastic-laminate sign on each major unit of electrical equipment in building; including central or master unit of each electrical system including communication/ control/signal systems, unless unit is specified with its own self-explanatory identification or signal system. Except as otherwise indicated, provide single line of text, 1/2" high lettering, on 1-1/2" high sign (2" high where 2 lines are required), black lettering in white field, or white lettering in a black field. Provide text matching terminology and numbering of the contract documents and shop drawings. Provide signs for each unit of the following categories of electrical work:
1. Switchboard, panelboards, electrical cabinets, disconnect switches and enclosures, transfer switches, UPS equipment.
 2. Access panel/doors to electrical facilities
 3. Transformers
 4. Fire alarm control panel and terminal cabinets
 5. Each breaker is in all switchboards and all distribution and branch circuit panels
 6. Each starter, VFD or other control devices. Contactors, timeclocks, etc.
- B. Install signs at locations indicated or, where not otherwise indicated, at location for best convenience of viewing without interference with operation and maintenance of equipment. Secure to substrate with fasteners, except use adhesive where fasteners should not or cannot penetrate substrate.

END OF SECTION 26 05 53

SECTION 26 05 73
OVERCURRENT PROTECTIVE DEVICE COORDINATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00.
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) requirements.

1.03 SUMMARY

- A. Section includes computer-based, overcurrent protective device coordination studies to determine overcurrent protective devices and to determine overcurrent protective device settings for selective tripping. Include arc flash calculations and data required for switchboard and panelboard arc flash labels.
 - 1. Study results shall be used to confirm coordination of device settings, and all code required arc-flash labeling.

1.04 DEFINITIONS

- A. One-Line Diagram: A diagram which shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.
- B. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion from the system.
- C. SCCR: Short-circuit current rating.
- D. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.

1.05 ACTION SUBMITTALS

- A. Product Data: For computer software program to be used for studies.
- B. Other Action Submittals: Submit the following after the approval of system protective devices submittals. Submittals shall be in digital form.
 - 1. Coordination-study input data, including completed computer program input data sheets.
 - 2. Study and equipment evaluation reports.

3. Overcurrent protective device coordination study report; signed, dated, and sealed by a qualified professional engineer. Report shall include a table of all project breakers and all settings for all trip setting adjustments, including emergency generator breakers and all GFI protection and ground fault indication settings.
 - a. Submit study report for action prior to receiving final approval of the distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect-Engineer for preliminary submittal of sufficient study data to ensure that the selection of devices and associated characteristics is satisfactory.

1.06 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Coordination Study Software and Coordination Study Specialist.
- B. Product Certificates: For overcurrent protective device coordination study software, certifying compliance with IEEE 399.

1.07 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For the overcurrent protective devices to include in emergency, operation, and maintenance manuals.
 1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 - a. The following parts from the Protective Device Coordination Study Report:
 - 1) One-line diagram.
 - 2) Protective device coordination study.
 - 3) Time-current coordination curves.
 - b. Power system data, including all final breaker trip settings.

1.08 QUALITY ASSURANCE

- A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are unacceptable.
- B. Coordination Study Software Developer Qualifications: An entity that owns and markets computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.
 1. The computer program shall be developed under the charge of a licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.
- C. Coordination Study Specialist Qualifications: Professional engineer in charge of performing the study and documenting recommendations, licensed in the state of Florida.

All elements of the study shall be performed under the direct supervision and control of this professional engineer.

- D. Field Adjusting Qualifications: Personnel with the experience and capability to adjust overcurrent devices and to conduct the testing indicated, and that is acceptable to authorities having jurisdiction.

PART 2 - PRODUCTS

2.01 COMPUTER SOFTWARE DEVELOPERS

- A. Software Developers: Subject to compliance with all of the contract documents, manufacturers offering products that meet the requirements of these specifications may be considered.
- B. Comply with IEEE 242 and IEEE 399.
- C. Analytical features of device coordination study computer software program shall have the capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.
- D. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices and shall demonstrate selective coordination by computer-generated, time-current coordination plots.
 - 1. Additional Features:
 - a. Arcing faults.

2.02 PROTECTIVE DEVICE COORDINATION STUDY REPORT CONTENTS

- A. Executive summary.
- B. Study descriptions, purpose, basis and scope. Include case descriptions, definition of terms and guide for interpretation of the computer printout.
- C. One-line diagram, showing the following:
 - 1. Protective device designations and ampere ratings.
 - 2. Cable size and lengths.
 - 3. Transformer kilovolt ampere (kVA) and voltage ratings.
 - 4. Motor and generator designations and kVA ratings.
 - 5. Switchgear, switchboard, motor-control center, and panelboard designations.
- D. Study Input Data: As described in "Power System Data" Article.
- E. Short-Circuit Study Output: Short circuit level indicated on the drawings at the power company transformer may be used for coordination.

F. Protective Device Coordination Study:

1. Report recommended settings of protective devices, ready to be applied in the field. Use manufacturer's data sheets for recording the recommended setting of overcurrent protective devices when available.
 - a. Phase and Ground Relays or adjustable ground fault trips
 - 1) Device tag.
 - 2) Relay current transformer ratio and tap, time dial, and instantaneous pickup value.
 - b. Circuit Breakers:
 - 1) Adjustable pickups and time delays (long time, short time, ground).
 - 2) Adjustable time-current characteristic.
 - 3) Adjustable instantaneous pickup.
 - 4) Recommendations on improved trip systems, if applicable.
 - c. Fuses: Show current rating, voltage, and class.

G. Time-Current Coordination Curves: Determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:

1. Device tag and title, one-line diagram with legend identifying the portion of the system covered.
2. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which the device is exposed.
3. Identify the device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.
4. Plot the following listed characteristic curves, as applicable:
 - a. Power utility's overcurrent protective device.
 - b. Medium-voltage equipment overcurrent relays.
 - c. Medium- and low-voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands.
 - d. Low-voltage equipment circuit-breaker trip devices, including manufacturer's tolerance bands.
 - e. Transformer full-load current, magnetizing inrush current, and ANSI through-fault protection curves.
 - f. Cables and conductors damage curves.

- g. Ground-fault protective devices.
 - h. Motor-starting characteristics and motor damage points.
 - i. Generator short-circuit decrement curve and generator damage point.
 - j. The largest feeder circuit breaker in each motor-control center and panelboard.
5. Series ratings are not acceptable.
 6. Provide adequate time margins between device characteristics such that selective operation is achieved.
 7. Comments and recommendations for system improvements.
- H. Arc flash labeling data shall be included.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance. Devices to be coordinated are indicated on Drawings.
1. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to coordination study may not be used in study.
 2. Overcurrent protective devices shall not be released prior to submittal and acceptance of the coordination study.

3.02 PROTECTIVE DEVICE COORDINATION STUDY

- A. Comply with IEEE 242 for calculating short-circuit currents and determining coordination time intervals.
- B. Comply with IEEE 399 for general study procedures.
- C. The study shall be based on the device characteristics supplied by device manufacturer.
- D. The extent of the electrical power system to be studied is indicated on Drawings.
- E. Begin analysis at the service, extending down to the system overcurrent protective devices as follows:
1. To normal and emergency power system low-voltage load buses where fault current is 10 kA or less.
- F. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Study all cases of system-switching configurations and alternate operations that could result in maximum fault conditions.
- G. Transformer Primary Overcurrent Protective Devices:

1. Device shall not operate in response to the following:
 - a. Inrush current when first energized.
 - b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
 - c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.
 2. Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.
- H. Motor Protection:
1. Select protection for low-voltage motors according to IEEE 242 and NFPA 70.
 2. Select protection for motors served at voltages more than 600 V according to IEEE 620.
- I. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and protection recommendations in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.
- J. Generator Protection: Select protection according to manufacturer's written recommendations and to IEEE 242.
- K. The calculations shall include the ac fault-current decay from induction motors, synchronous motors, and asynchronous generators and shall apply to low- and medium-voltage, three-phase ac systems. The calculations shall also account for the fault-current dc decrement, to address the asymmetrical requirements of the interrupting equipment.
1. For grounded systems, provide a bolted line-to-ground fault-current study for areas as defined for the three-phase bolted fault short-circuit study.
- L. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault and single line-to-ground fault at each of the following:
1. Electric utility's supply termination point.
 2. Low-voltage switchgear.
 3. Standby generators and automatic transfer switches.
 4. Branch circuit panelboards.
- M. Protective Device Evaluation:
1. Evaluate equipment and protective devices and compare to short-circuit ratings.
 2. Adequacy of switchgear, motor-control centers, and panelboard bus bars to withstand short-circuit stresses.

3. Any application of devices shall be reviewed for compliance with requirements in NFPA 70. Series rated devices are not permitted.

3.03 POWER SYSTEM DATA

- A. Obtain all data necessary for the conduct of the overcurrent protective device study.
 1. Verify completeness of data supplied in the one-line diagram on Drawings. Call discrepancies to the attention of Architect-Engineer.
 2. For new equipment, use characteristics submitted under the provisions of action submittals and information submittals for this Project.
- B. Gather and tabulate the following input data to support coordination study. The list below is a guide. Comply with recommendations in IEEE 551 for the amount of detail required to be acquired in the field. Field data gathering shall be under the direct supervision and control of the engineer in charge of performing the study.
 1. Product Data for overcurrent protective devices specified in other Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
 2. Electrical power utility impedance at the service.
 3. Power sources and ties.
 4. Short-circuit current at each system bus, three phase and line-to-ground.
 5. Full-load current of all loads.
 6. Voltage level at each bus.
 7. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.
 8. For reactors, provide manufacturer and model designation, voltage rating, and impedance.
 9. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip and available range of settings, SCCR, current rating, and breaker settings.
 10. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
 11. For relays, provide manufacturer and model designation, current transformer ratios, potential transformer ratios, and relay settings.
 12. Motor horsepower and NEMA MG 1 code letter designation.
 13. Low-voltage cable sizes, lengths, number, conductor material, and conduit material (magnetic or nonmagnetic).

14. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram, showing the following:
 - a. Special load considerations, including starting inrush currents and frequent starting and stopping.
 - b. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.
 - c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
 - d. Generator thermal-damage curve.
 - e. Ratings, types, and settings of utility company's overcurrent protective devices.
 - f. Special overcurrent protective device settings or types stipulated by utility company.
 - g. Time-current-characteristic curves of devices indicated to be coordinated.
 - h. Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
 - i. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
 - j. Panelboards, switchboards, motor-control center ampacity, and SCCR in amperes rms symmetrical.

3.04 FIELD ADJUSTING

- A. Adjust relay and protective device settings according to the recommended settings provided by the coordination study. Field adjustments shall be completed by the engineering service division of the equipment manufacturer under the Startup and Acceptance Testing contract portion.
- B. Make minor modifications to equipment as required to accomplish compliance with protective device coordination studies.
- C. Testing and adjusting shall be by a full-time employee of the contractor.

3.05 DEMONSTRATION

- A. Engage the Coordination Study Specialist to train Owner's maintenance personnel in the following:
 1. Acquaint personnel in the fundamentals of operating the power system in normal and emergency modes.

2. Hand-out and explain the objectives of the coordination study, study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpreting the time-current coordination curves.
3. Adjust, operate, and maintain overcurrent protective device settings.

END OF SECTION 26 05 73

SECTION 26 09 23
LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other related Specification sections, apply to this section.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00.
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) requirements.

1.03 SUMMARY

- A. Section Includes:
 - 1. Time switches.
 - 2. Photoelectric switches.
 - 3. Standalone daylight-harvesting switching and dimming controls.
 - 4. Indoor occupancy and vacancy sensors.
 - 5. Digital timer light switches.
 - 6. Low voltage on/off lighting control
 - 7. Low voltage on/off with dimming control
 - 8. Lighting contactors.
 - 9. Emergency shunt relays.
- B. Related Requirements:
 - 1. Section 26 27 26 "Wiring Devices" for wall-box dimmers, non-networkable wall-switch occupancy sensors, and manual light switches.
 - 2. Section 28 13 00 “Access Control Software and Database Management”.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings:
 - 1. Show installation details for the following:

- a. Occupancy sensors (if applicable).
 - b. Vacancy sensors (manual on/auto off controls).
 - c. Low voltage dimmers and controls, including emergency shunt and relays
2. Interconnection diagrams showing field-installed wiring method and connections for each individual control scheme, including emergency power bypass controls.
 3. Include diagrams for power, signal, and control wiring.
 4. Submit layout drawings for all occupancy sensors with manufacturer-recommended coverage and device.

1.05 CONTROLS INTEGRATION WITH MASTER CONTROLS SYSTEM

- A. This controls system shall be seamlessly integrated into and be subservient to the master building controls system. The master system will have other subservient systems integrated into it. The master system is specified in section 281300 Access Control Software and Database Management.
- B. This division contractor shall work with master controls contractor / vendor as needed to facilitate the integration.
- C. Provide all required licensing and software needed for integration of this system into the master system.
- D. Coordinate tiered security access through the master system to permit access to the approved list of personnel with various skills sets.
- E. Programing and controls sequences specific to this division shall not be performed through the master system.

1.06 INFORMATIONAL SUBMITTALS

- A. Warranty: For manufacturer's warranties.

1.07 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each type of lighting control device to include in operation and maintenance manuals.
- B. Software and Firmware Operational Documentation:
 1. Software operating and upgrade manuals.
 2. Program Software Backup (where applicable): On USB media. Provide names, versions, and website addresses for locations of installed software.
 3. Device address list.
 4. Printout of software application and graphic screens.

1.08 WARRANTY

- A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace lighting control devices that fail(s) in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Faulty operation of lighting control software.
 - b. Faulty operation of lighting control devices, including but not limited to delayed on/off, delayed dimming, flickering of lights, flickering of dimming above 10% dim.
 - 2. Warranty Period: Two year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Bases of design manufacturer is Acuity Brand nLight or equivalent controls by Wattstopper or Eaton.
- B. Lighting controls shall be capable of integration with Genetec system (provided by others) via BACnet to allow room level controls (on/off, time, dimming, etc.) per owner preference.

2.02 TIME SWITCHES

- A. Electronic Time Switches: Solid state, programmable, with alphanumeric display; complying with UL 917.
 - 1. Listed and labeled as defined in NFPA 70 and marked for intended location and application.
 - 2. Contact Configuration: SPST, DPST, DPDT, as required
 - 3. Contact Rating: 30-A inductive or resistive, 240-V ac, 20-A ballast load, 120-/240-Volt, as required.
 - 4. Programs: Eight on-off set points on a 24-hour schedule, and an annual holiday schedule that overrides the weekly operation on holidays.
 - 5. Circuitry: Allow connection of a photoelectric relay as substitute for on-off function of a program.
 - 6. Astronomic Time: All channels.
 - 7. Automatic daylight savings time changeover.
 - 8. Battery Backup: Not less than seven days reserve, to maintain schedules and time clock.

2.03 OUTDOOR PHOTOELECTRIC SWITCHES

- A. Description: Solid state, with SPST or DPST, as required, dry contacts rated for 1500 W LED, to operate connected relay, contactor coils, or microprocessor input; complying with UL 773A, and compatible with ballasts and LED lamps.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Light-Level Monitoring Range: 1.5 to 10 fc (16.14 to 108 lux), with an adjustment for turn-on and turn-off levels within that range[, and a directional lens in front of the photocell to prevent fixed light sources from causing turn-off].
3. Time Delay: Fifteen-second minimum, to prevent false operation.
4. Surge Protection: Metal-oxide varistor.
5. Mounting: Twist lock complies with NEMA C136.10, with base-and-stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the north sky exposure.
6. Failure Mode: Luminaire stays ON.

2.04 DAYLIGHT-HARVESTING SWITCHING CONTROLS

- A. System Description: System operates indoor lighting, including sensors that are integral with luminaires.
- B. Sequence of Operation: As daylight increases, the lights are turned off at a predetermined level. As daylight decreases, the lights are turned on at a predetermined level.
 1. Lighting control set point is based on two lighting conditions:
 - a. When no daylight is present.
 - b. When significant daylight is present (target level).
 - c. System programming is done with two hand-held, remote-control tools.
- C. Ceiling-Mounted Switching Controls: Solid-state, light-level sensor unit, with power pack, that detects changes in indoor lighting levels that are perceived by the eye.
- D. Electrical Components, Devices, and Accessories:
 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 2. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F (0 to 49 deg C).
 3. Sensor Output: Contacts rated to operate the associated power pack, complying with UL 773A. Sensor shall be powered by the power pack.
 4. Sensor Output: Digital signal compatible with power pack.
 5. Sensor type: Open loop or Closed loop.
 6. Zone: Single or Multi.
 7. Power Pack: Dry contacts rated for 20-A LED load at 120- and 277-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.

- a. LED status lights to indicate load status.
- b. Plenum rated.
- 8. Power Pack: Digital controller capable of accepting required number of RJ45 inputs with the required number of outputs rated for 20-A LED load at 120- and 277-V ac. Sensor has 24-V dc Class 2 power source, as defined by NFPA 70.
 - a. With integral current monitoring
 - b. Compatible with digital addressable lighting interface.
 - c. Plenum rated.
- 9. General Space Sensors Light-Level Monitoring Range: 10 to 200 fc (108 to 2152 lux), with an adjustment for turn-on and turn-off levels within that range.
- 10. Time Delay: Adjustable from 5 to 300 seconds to prevent cycling.
- 11. Set-Point Adjustment: Equip with deadband adjustment of 25, 50, and 75 percent above the "on" set point, or provide with separate adjustable "on" and "off" set points.
- 12. Test Mode: User selectable, overriding programmed time delay to allow settings check.
- 13. Control Load Status: User selectable to confirm that load wiring is correct.
- 14. Indicator: Two digital displays to indicate the beginning of on-off cycles.

2.05 DAYLIGHT-HARVESTING DIMMING CONTROLS

- A. System Description: Sensing daylight and electrical lighting levels, the system adjusts the indoor electrical lighting levels. As daylight increases, the lights are dimmed.
 - 1. Lighting control set point is based on two lighting conditions:
 - a. When no daylight is present (target level).
 - b. When significant daylight is present.
 - 2. System programming is done with two hand-held, remote-control tools.
 - a. Initial setup tool.
 - b. Tool for occupants to adjust the target levels by increasing the set point up to 25 percent, or by minimizing the electric lighting level.
- B. Ceiling-Mounted Dimming Controls: Solid-state, light-level sensor unit, with power pack mounted on luminaire or in ceiling, to detect changes in indoor lighting levels that are perceived by the eye.
- C. Electrical Components, Devices, and Accessories:
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2. Sensor Output: 0- to 10-V dc to operate luminaires. Sensor is powered by controller unit.
 3. Light-Level Sensor Set-Point Adjustment Range: 20 to 60 fc (120 to 640 lux).
- D. Power Pack: Dry contacts rated for 20-A LED load at 120- and 277-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.
1. LED status lights to indicate load status.
 2. Plenum rated.
- E. Power Pack: Digital controller capable of accepting the required number of RJ45 inputs with the required number of outputs rated for 20-A LED load at 120- and 277-V ac, for LED. Sensor has 24-V dc Class 2 power source, as defined by NFPA 70.
1. With integral current monitoring
 - a. Compatible with digital addressable lighting interface.
 - 1) Plenum rated.

2.06 INDOOR OCCUPANCY AND VACANCY SENSORS

- A. General Requirements for Sensors:
1. Wall or Ceiling-mounted, solid-state indoor occupancy and vacancy sensors.
 2. Dual technology.
 3. Separate power pack.
 4. Hardwired connection to compatible switch and BAS. On/off switches and on/off dimmer switches shall be 100% compatible with the sensors.
 5. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 6. Operation:
 - a. Occupancy Sensor: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
 - b. Vacancy Sensor: Unless otherwise indicated, lights are manually turned on and sensor turns lights off when the room is unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes. **NOTE: PROVIDE VACANCY SENSORS IN ALL LOCATIONS REQUIRED BY THE FLORIDA ENERGY CODE.**
 7. Sensor Output: Sensor is powered from the power pack.
 8. Power: Line voltage.
 9. Power Pack: Dry contacts rated for 20-A ballast or LED. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.

10. Mounting:
 - a. Sensor: Suitable for mounting in any position on a standard outlet box.
 - b. Relay: Externally mounted through a 1/2-inch knockout in a standard electrical enclosure.
 - c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
 11. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.
 12. Bypass Switch: Override the "on" function in case of sensor failure.
- B. Dual-Technology Type: Ceiling mounted; detect occupants in coverage area using PIR and ultrasonic detection methods. The particular technology or combination of technologies that control on-off functions is selectable in the field by operating controls on unit.
1. Sensitivity Adjustment: Separate for each sensing technology.
 2. Detector Sensitivity: Detect occurrences of 6-inch-minimum movement of any portion of a human body that presents a target of not less than 36 sq. in., and detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s.
 3. Detection Coverage: Detect occupancy anywhere within a circular area of 1000 sq. ft. when mounted on a 10 foot high ceiling. Provide for detection coverage for higher ceilings and larger areas as required by the areas indicated on the drawings.

2.07 DIGITAL TIMER LIGHT SWITCH

- A. Description: Combination digital timer and conventional switch lighting control unit. Switchbox-mounted, backlit LCD display, with selectable time interval in 10 minute increments.
1. Rated 960 W at 120-V ac for tungsten lighting, 10 A at 120-V ac or 10 amps at 277-V ac for LED, and 1/4 horsepower at 120-V ac.
 2. Integral relay for connection to BAS.
 3. Voltage: Dual voltage - 120 and 277 V.
 4. Color: White
 5. Faceplate: Stainless steel.

2.08 LIGHTING CONTACTORS

- A. Description: Electrically operated and mechanically held, lighting contactors, complying with NEMA and UL 508. Provide NEMA rated contactors.

1. Current Rating for Switching: Listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush ballast (ballast with 15 percent or less THD of normal load current).
 2. Fault Current Withstand Rating: Equal to or exceeding the available fault current at the point of installation.
 3. Enclosure: Comply with NEMA 250.
 4. Provide with control and pilot devices as indicated on Drawings, matching the NEMA type specified for the enclosure.
- B. Interface with DDC System for HVAC: Provide hardware interface to enable the DDC system for HVAC to monitor and control lighting contactors.
1. Monitoring: On-off status, Points as required.
 2. Control: On-off operation, Points as required.

2.09 EMERGENCY SHUNT RELAY

1. Coil Rating: 120 or 277 V, as required.
2. Provide emergency bypass relays to bypass all switching and dimming when the emergency life safety transfer switch is in the emergency generator power position.
3. Acuity Brands model # NPP16 ER EFP or equivalent by Wattstopper or Eaton.
4. Acuity Brands model # NPP16 ER EFP SA or equivalent by Wattstopper or Eaton.
5. Acuity Brands model # NPP16 D ER EFP or equivalent by Wattstopper or Eaton.
6. Acuity Brands model # NPP16 D ER EFP SA or equivalent by Wattstopper or Eaton.

2.10 LOW VOLTAGE DIMMING CONTROLS

- A. Provide low voltage wall mounted lighting control stations with integral manual on/ auto off and 0-10 volt dimming control. Stations shall be compatible with the power packs, vacancy sensors, LED drivers and LED lamps. Dimmers for LED lighting shall be matched with the LED driver and LED types. Submit all dimmers for LED for approval. Submittal shall have written documentation that the dimmer is suitable for use with the specific LED driver and LED's being used in the dimmed fixture. Station shall be gray, and provided with a Decora style coverplate, stainless steel. Where 3-way control is required, provide dimmer that is compatible with the 3-way switching.

2.11 LOW VOLTAGE LIGHTING CONTROLS

- A. Provide low voltage wall mounted lighting control stations with integral manual on/ auto off. Stations shall be compatible with the power packs, vacancy sensors, LED drivers and LED lamps. Submittal shall have written documentation that the dimmer is suitable for use with the specific LED driver and LED's being used in the dimmed fixture.

Station shall be gray, and provided with a Decora style coverplate, stainless steel. Provide for 3-way control where required.

2.12 LOW VOLTAGE LIGHTING CONTROL POWER PACKS

- A. Provide low voltage power packs for the control of the occupancy sensors, daylight harvesting (where indicated), on/off wall stations, and on/off dimming control stations. Power packs shall be Class 1 high voltage (120/277 volt) to Class 2 low voltage (15 Vdc), plenum rated. Power packs shall meet all codes and all National Electrical Code requirements. Provide single or dual circuit as required. Provide for emergency power circuits and bypass relay controls for automatic illumination of all emergency egress lighting in the event of utility power failure.

2.13 CONDUCTORS AND CABLES

- A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."
- B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."
- C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."
- D. All lighting control wiring that is free-wired shall be plenum rated and shall be supported to a building structural member at 5 foot intervals minimum.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine lighting control devices before installation. Reject lighting control devices that are wet, moisture damaged, or mold damaged.
- B. Examine walls and ceilings for suitable conditions where lighting control devices will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 SENSOR INSTALLATION

- A. Comply with NECA 1.
- B. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.
- C. Install and aim sensors in locations to achieve not less than 90-percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

3.03 CONTACTOR INSTALLATION

- A. Comply with NECA 1.

3.04 WIRING INSTALLATION

- A. Comply with NECA 1.
- B. Wiring Method: Comply with Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size is 1/2 inch.
- C. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.
- D. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.
- E. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.05 IDENTIFICATION

- A. Identify components and power and control wiring according to Section 26 05 53 "Identification for Electrical Systems."
 - 1. Identify controlled circuits in lighting contactors.
 - 2. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.
- B. Label time switches and contactors with a unique designation.

3.06 FIELD QUALITY CONTROL

- A. Testing Agency: Commissioning agent will evaluate lighting control devices and witness tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- C. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - 1. Operational Test: After installing time switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - 3. Tests shall be performed (or performed again) in the presence of the commissioning agent.
- D. Lighting control devices will be considered defective if they do not pass tests and inspections.

- E. Prepare test and inspection reports.

3.07 ADJUSTING

- A. Occupancy Adjustments: When requested within 3 months from date of Substantial Completion, provide on-site assistance in adjusting lighting control devices to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.
 - 1. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.
 - 2. For daylighting controls, adjust set points and deadband controls to suit Owner's operations.

3.08 SOFTWARE SERVICE AGREEMENT

- A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.
- B. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.
 - 1. Upgrade Notice: At least 30 days to allow Owner to schedule and access the system and to upgrade computer equipment if necessary.
- C. Coordinate integration between the lighting control system(s) and the Genetec system with their manufacturer's reps.

3.09 DEMONSTRATION

- A. Engage a factory-authorized service representative to verify lighting controls are installed per manufacturer guidelines and train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices.
- B. Before the final inspection, the contractor shall engage a lighting commissioning agent and submit evidence to the registered design professional (electrical engineer-of-record) or registered design professional's representative that the lighting control systems have been tested to ensure that they are calibrated, adjusted, programmed, and satisfy the intent of the contract documents and the manufacturer's written instructions. Functional testing shall be performed in accordance with FBC c408.3.1.1 (occupant sensor controls), FBC c408.3.1.2 (time-switch controls), and/or FBC c408.3.1.3 (daylight responsive controls) (as required).

END OF SECTION 26 09 23

SECTION 26 22 00
LOW VOLTAGE DISTRIBUTION TRANSFORMERS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and other related Specification sections, apply to work of this section.
- B. Division-26 Basic Electrical Materials and Methods sections apply to work specified in this section.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00.
 - 1. Refer to "PART 2 – PRODUCTS" for all Buy America Build America Act (BABA) requirements.

1.02 DESCRIPTION OF WORK:

- A. Extent of the low voltage dry type transformer work is indicated by drawings and schedules.
- B. This section includes dry-type distribution transformers with primary and secondary voltages of 600V and less and capacity ratings through 500 kVA.

1.03 SUBMITTALS:

- A. Product Data: Submit manufacturer's data on transformers including, but not limited to, voltages, number of phases, frequencies, temperature rating, sound levels, KVA ratings, K rating and short-circuit and continuous current ratings. Provide dimensions and weights of all transformers

1.04 OPERATION AND MAINTENANCE MANUALS

- A. Provide complete operation and maintenance manuals for the transformers. The manuals shall contain complete operation and maintenance procedures and parts lists.

1.05 QUALITY ASSURANCE:

- A. Manufacturer's Qualifications: Firms regularly engaged in the manufacture of transformers, of types, sizes and capacities required, and whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Installer's Qualifications: Firm with at least 5 years of successful installation experience on projects utilizing transformers similar to that required for this project. Installer shall be a licensed electrician with experience installing at least ten transformers of equal size and scope.

1.06 CODES AND STANDARDS:

- A. Electrical Code Compliance: Comply with applicable local code requirements of the authority having jurisdiction, and that portion of the NEC which pertains to installation and construction of dry type transformers.
- B. UL Compliance: Comply with applicable requirements of UL pertaining to installation and construction of dry type transformers. Provide dry type transformers which are UL-listed and labeled.
- C. NEMA Compliance: Comply with applicable portions of NEMA pertaining to dry type transformers.
- D. Comply with NEMA ST 20, and list and label as complying with UL 1561. Comply with current federal and industry standard energy efficiency requirements.

1.07 DELIVERY, STORAGE, AND HANDLING:

- A. Deliver dry type transformers and components properly packaged and mounted on pallets, or skids to facilitate handling of heavy items. Utilize factory-fabricated type containers or wrappings for dry type transformers which protect equipment from damage. Inspect equipment to ensure that no damage has occurred during shipment.
- B. Store dry type transformers in original packaging and protect from weather and construction traffic. Wherever possible, store indoors; where necessary to store outdoors, store above grade and enclose with watertight wrapping.
- C. Handle dry type transformers carefully to prevent physical damage to equipment and components. Remove packaging, including the opening of crates and containers, avoiding the use of excessive hammering and jarring which would damage the electrical equipment contained therein. Do not install damaged equipment; remove from site and replace damaged equipment with new.

1.08 SEQUENCING AND SCHEDULING:

- A. Schedule delivery of dry type transformers which permits ready building ingress for large equipment components to their designated installation spaces. Coordinate delivery of equipment with the installation of other building components.
- B. Provide the size and location of concrete equipment pads. Cast anchor bolt inserts into pad.
- C. Coordinate with other electrical work including raceways, electrical boxes and fittings, and cabling/wiring work, as necessary to interface installation of switchboards with other work.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

- A. Subject to compliance with all of the contract documents, manufacturers offering products that meet the requirements of these specifications may be considered. The following are considered acceptable, subject to compliance with these specifications:

1. Square D
2. ABB
3. Siemens
4. Eaton

2.02 RATINGS INFORMATION

- A. Transformer insulation shall be a UL recognized 150°C temperature class system. Neither the primary nor the secondary temperature shall exceed 150°C at any point in the coils while carrying their full rating of non-sinusoidal load. Neutrals shall be rated to carry 200% of the rated secondary current, unless specifically noted otherwise on the drawings. The maximum temperature hot spot temperatures shall not exceed the 30°C hot spot rating for the indicated K factors, defined as the sum of fundamental and harmonic per ANSI/IEEE C57.110-1986. All dry type transformers shall have a K factor of 13, unless specifically noted otherwise on the drawings. Manufacturers rating K factors by average temperature rise alone shall not be acceptable.
- B. Some transformers are not required to be K rated. Transformers requiring a K rating are specifically noted on the drawings. Other transformers may be standard rated. These transformers shall have the same construction as specified herein except they are not required to have a 200% neutral or K rating.

2.03 TRANSFORMER CONSTRUCTION

- A. Transformer coils shall be of the continuous wound copper construction and shall be impregnated with non-hygroscopic, thermosetting varnish. Continuous windings without splices except for taps. Equivalent aluminum coil will be permitted, except for the UPS power distribution unit transformers shall be copper.
- B. Transformers 15kVA and larger shall have a minimum of 6-2.5% full capacity primary taps for 480V primaries. Exact voltages and taps to be as designated on the plans or the transformer schedule.
- C. All cores to be constructed with low hysteresis and eddy current losses. The core flux density shall be well below the saturation point to prevent core overheating caused by harmonic voltage distortion. Manufacturers shall submit verification of induction levels well below the usual level for standard transformers. Grain-oriented, non-aging silicon steel.
- D. Transformers shall be common core construction. Transformers utilizing more than one core, or Scott-T connections, shall not be acceptable.
- E. The transformer secondary neutral terminal shall be sized for 200% of the secondary phase current.
- F. The transformer enclosures shall be ventilated and be fabricated of heavy gauge, sheet steel construction. The entire enclosure shall be finished utilizing a continuous process consisting of degreasing, cleaning and phosphatizing, followed by electrostatic deposition of a polymer polyester powder coating and baking cycle to provide uniform coating of all edges and surfaces. The coating shall be UL recognized for outdoor use. The coating color shall be ANSI 49.

- G. The maximum temperature of the top of the enclosure shall not exceed 50°C rise above 40°C ambient.
- H. Transformers shall be supplied with a quality, full width electrostatic shield resulting in a maximum effective coupling capacitance between primary and secondary of 33 picofarads. With transformers connected under normal, loaded operating conditions, the attenuation of line noise and transients shall equal or exceed the following limits:
 - 1. Common Mode: 0 to 1.5Hz - 120db; 1.5 to 10kHz - 90db; 10 to 100kHz - 65db; 100kHz to 40db.
 - 2. Traverse Mode: 1.5 to 10kHz - 52db; 10 to 100kHz - 30db
- I. Sound levels shall be warranted by the manufacturer not to exceed the following:
 - 1. 15 to 50kVA - 45db; 51 to 150kVA - 50db; 151 to 300kVA - 55db; 301 to 500kVA - 60db.

2.04 OPTIONAL ACCESSORIES

- A. Provide wall mounting brackets for units where wall mounting is indicated.
- B. Provide ceiling mounting brackets for units ceiling mounting is indicated.

2.05 APPLICABLE STANDARDS

- A. All insulation materials are to be in accordance with NEMA ST20 standards for 220°C UL component recognized insulation system. Transformers are to be manufactured and tested in accordance with ANSI Standard C57.12.91 and NEMA ST20.
- B. Transformers of 500kVA or smaller shall be listed by Underwriters Laboratory.
- C. Energy Efficiency for Transformers Rated 15 kVA and Larger:
 - 1. Complying with NEMA TP 1, Class 1 efficiency levels.
 - 2. Tested according to NEMA TP 2.

PART 3 - EXECUTION

3.01 EXAMINATION:

- A. Examine areas and conditions under which dry type transformers and components are to be installed, and notify Contractor in writing of conditions detrimental to proper completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to the Installer.

3.02 INSTALLATION OF DRY TYPE TRANSFORMERS:

- A. Transformers shall be installed securely and level. All code required clearances shall be provided and access for cleaning and adjustment shall be provided.
- B. Provide neoprene isolation pads between the transformer enclosure and the concrete pad.
- C. Concrete equipment mounting pad shall be provided.

3.03 FIELD QUALITY CONTROL:

- A. Prior to energization of circuitry, check all accessible connections to manufacturer's torque tightening specifications.

3.04 ADJUSTING AND CLEANING:

- A. Adjust operating mechanisms for free mechanical movement.
- B. Touch-up scratched or marred surfaces to match original finishes.

3.05 GROUNDING:

- A. Provide equipment grounding connections for dry type transformers as indicated or required by the National Electrical Code. Tighten connections to comply with tightening torques specified in UL Std 486A to assure permanent and effective grounds.

3.6 WARRANTY

- A. All transformers shall be guaranteed against defective material and workmanship in accordance with the manufacturers published warranty for a minimum of one year from the date of the substantial completion. Warranty shall be published in the name of the Owner, not the contractor.

END OF SECTION 26 22 00

SECTION 26 24 13
SWITCHBOARDS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions sections, apply to work of this section.
- B. Division-26 Basic Electrical Materials and Methods sections apply to work specified in this section.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00.
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) requirements.

1.03 DESCRIPTION OF WORK:

- A. Extent of switchboard work is indicated by drawings and schedules. The existing switchboard shall have new breakers installed as required, plus an additional section added if necessary. This specification addresses the full switchboard requirements, but shall be only as applies to the project.
- B. Types of switchboards specified in this section include the following:
 - 1. Low Voltage Circuit Breaker Switchboards.

1.04 SUBMITTALS:

- A. Product Data: Submit manufacturer's data on switchboards including, but not limited to, voltages, number of phases, frequencies, and short-circuit and continuous current ratings. Provide application data for main and branch circuit-breakers, sections, main buses, metering equipment, and basic insulation levels.
- B. Shop Drawings: Submit dimensioned layout drawings of switchboards showing accurately scaled basic equipment sections including auxiliary compartments, section components, and combination sections. Drawings shall be shown in plan and elevation. Bus arrangements shall be indicated. All circuit breakers shall be identified and location shown, including spaces.
- C. Provide complete time-current curves for all circuit breakers to enable the determination of appropriate trip settings. Refer to the coordination specification, 26 0573.

1.05 OPERATION AND MAINTENANCE MANUALS

- A. Provide complete operation and maintenance manuals for the switchboard and circuit breakers. The manuals shall contain record as-built drawings of the switchboard,

including wiring diagrams. The manuals shall contain complete operation and maintenance procedures and parts lists.

1.06 QUALITY ASSURANCE:

- A. Manufacturer's Qualifications: Firms regularly engaged in the manufacture of switchboards, of types, sizes and capacities required, and whose products have been in satisfactory use in similar service for not less than 20 years.
- B. Installer's Qualifications: Firm with at least 20 years of successful installation experience on projects utilizing switchboard units similar to that required for this project. Installer shall be a licensed electrician with experience installing at least three switchboards of equal size and scope.

1.07 CODES AND STANDARDS:

- A. Electrical Code Compliance: Comply with applicable local code requirements of the authority having jurisdiction, and that portion of the NEC which pertains to installation and construction of switchboards.
- B. UL Compliance: Comply with applicable requirements of UL 486A, "Wire Connectors and Soldering Lugs for Use with Copper Conductors", UL 489, "Molded-Case Circuit Breakers and Circuit Breaker Enclosures," and UL 891, "Dead-Front Electrical Switchboards," pertaining to installation and construction of switchboards. Provide switchboards and components which are UL-listed and labeled.
- C. NEMA Compliance: Comply with applicable portions of NEMA Stds Pub/No. PB 2, "Dead-front Distribution Switchboards"; PB 2.1, "General Instruction for Proper Handling, Installation, Operation and Maintenance of Deadfront Distribution Switchboards Rated 600 Volts or Less," and SG 3, "Low-Voltage Power Circuit Breakers," pertaining to switchboard assemblies.

1.08 DELIVERY, STORAGE, AND HANDLING:

- A. Deliver switchboards and components properly packaged and mounted on pallets, or skids to facilitate handling of heavy items. Utilize factory-fabricated type containers or wrappings for switchboards and components which protect equipment from damage. Inspect equipment to ensure that no damage has occurred during shipment.
- B. Store switchboard equipment in original packaging and protect from weather and construction traffic. Wherever possible, store indoors; where necessary to store outdoors, store above grade and enclose with watertight wrapping.
- C. Handle switchboard equipment carefully to prevent physical damage to equipment and components. Remove packaging, including the opening of crates and containers, avoiding the use of excessive hammering and jarring which would damage the electrical equipment contained therein. Do not install damaged equipment; remove from site and replace damaged equipment with new.

1.09 SEQUENCING AND SCHEDULING:

- A. Schedule delivery of switchboard equipment which permits ready building ingress for large equipment components to their designated installation spaces. Coordinate delivery of equipment with the installation of other building components.

- B. Provide the size and location of concrete equipment pads. Cast anchor bolt inserts into pad.
- C. Coordinate with other electrical work including raceways, electrical boxes and fittings, and cabling/wiring work, as necessary to interface installation of switchboards with other work.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

- A. Subject to compliance with all of the contract documents, manufacturers offering products that meet the requirements of these specifications may be considered. The following are considered acceptable, subject to compliance with these specifications:
 - 1. Square D
 - 2. ABB
 - 3. Siemens
 - 4. Eaton.

2.02 EQUIPMENT SECTIONS AND COMPONENTS:

- A. General: Except as otherwise indicated, provide switchboards and ancillary components of types, sizes, characteristics, and ratings indicated, which comply with manufacturer's standard design, materials, components, and construction in accordance with published product information, and as required for complete installation.
- B. AC Dead-Front Main Service Entrance Switchboards: Provide factory-assembled, dead-front, metal-enclosed, self-supporting secondary power switchboards, of types, sizes, electrical ratings and characteristics indicated; consisting of vertical panel units, and containing circuit-breakers of quantities, ratings and types indicated. Provide all copper main horizontal and vertical bus and connections to switching devices and circuit-breaker branches of sufficient capacity to limit rated continuous current operating temperature rise of no greater than 65 deg C above average ambient temperature of 30 deg C; with main bus and tap connections tin plated and bolted tightly according to manufacturer's torquing requirements for maximum conductivity. Brace bus for short-circuit stresses up to 100,000 amps interrupting capacity minimum or greater when indicated on the drawings. Provide accessibility of line and load terminations from front and side of switchboard. Prime and coat switchboard with manufacturer's standard finish and color. Equip units with built-in lifting eyes and yokes; and provide vertical individual panel units, suitable for bolting together at project site. Switchboard shall be U.L. service entrance rated and so labeled. Construct switchboard units for the following environment:
 - 1. Installation: Indoors, NEMA Type 1.
- C. Enclosures: Construct dead-front switchboards, suitable for floor mounting, with front and side cabling/wiring accessibility, and conduit accessibility. Provide welded steel channel framework; hinge wireway front covers to permit ready access to branch circuit-breaker load side terminals. Coat enclosures with manufacturer's standard corrosive-resistant finish.

- D. Circuit Breakers: Except as otherwise indicated, provide circuit breakers and ancillary components, of types, sizes, ratings and electrical characteristics indicated, which comply with manufacturer's standard design, materials, components, and construction in accordance with published product information, and as required for a complete installation.
1. All circuit breakers shall be constructed in accordance with the following standards:
 - a. UL 489
 - b. NEMA AB1
 - c. Federal Specification W-C 375B/GEN
 - d. CSA 22.2, no. 5-M1986
- E. Main Circuit Breaker and Feeder Breakers Equal to or Greater Than 1200 amps: Provide stationary mounted, electrically operated, insulated case circuit breaker of the ampere rating indicated on the drawings. Main circuit breakers shall be 100% continuous duty type. The circuit breaker shall be rated for A.I.C. indicated on the drawings and subsequently listed in the coordination study. These circuit breakers shall be provided with the following integral, adjustable settings:
1. Adjustable Instantaneous Trip.
 2. Long time pick-up and adjustable delay.
 3. Short time pick-up and adjustable delay.
 4. Adjustable high instantaneous pick-up.
 5. Adjustable ground fault pick-up and delay (ground fault only required on 480Y/277 volt systems).
- F. Feeder Circuit Breakers: Provide factory-assembled, molded-case, group mounted circuit breakers rated as indicated, 600-volts, 60 Hz, 3-poles with the RMS symmetrical interrupting ratings indicated on the drawings. All switchboards shall be fully rated. Series ratings are not acceptable. Construct with overcenter, trip-free, toggle-type operating mechanisms with quick-make, quick-break action and positive handle trip indication. Construct breakers for mounting and operating in an physical position and operating in an ambient temperature of 40 deg C. Provide breakers with mechanical screw type removable connector lugs, AL/CU rated, and with NEMA Type 1 general purpose enclosures.
1. Circuit breaker escutcheon shall have International I/O markings, in addition to standard ON/OFF markings. Circuit breaker handle accessories shall provide provisions for locking handle in the "ON" or "OFF" position.
 2. Breaker handle and faceplate shall indicate rated ampacity. Breaker faceplate shall indicate UL and IEC certification standards with applicable voltage systems and corresponding AIC ratings.
 3. Each circuit breaker shall be equipped with a push-to-trip button to mechanically operate the circuit breaker tripping mechanism. Each breaker shall have quick-make, quick-break contacts with an overcenter toggle operating mechanism. Breaker(s) shall not be able to be teased into a neutral position. All circuit breakers shall be equipped with electrical accessories as noted on the drawings.
 4. Electronic Trip System (400 amp trip feeder breakers and larger only):
 - a. The entire trip system shall be a microprocessor-based, peak sensing design.
 - b. The integral trip system shall be independent of any external power source and shall contain electronic components to measure ampacity and

- time the output from internal current sensors and initiate automatic tripping action.
- c. The continuous ampere rating of the circuit breaker shall be determined by the ampere rating switch position. The ampere rating shall be clearly marked on the face of the circuit breaker.
 - d. Provide a means to seal the trip unit adjustments to discourage unauthorized tampering in accordance with NEC 240-6. The trip unit shall be field interchangeable for future replacement.
 - e. Provide the following time/current curve profile adjustment(s) to maximize system selective coordination. Each adjustment shall have discrete settings and shall be independent from all other adjustments.
 - 1) LSI - Adjustable Ampere Rating Pickup and Delay
 - 2) Adjustable Short Time Pickup and Delay (delay includes I_{yt} IN)
 - 3) Fixed Instantaneous (High Level Selective Override)
 - f. Provide local visual trip indicators for overload, short circuit and ground fault trip functions.
 - g. The trip system shall include a memory circuit to detect intermittent overcurrent conditions.
 - h. Each circuit breaker trip system is to include an externally accessible test port for use with a Universal Test Set. No disassembly of the circuit breaker shall be required for testing. Test set shall be capable of verifying the operation of all trip functions with or without tripping the circuit breaker.
 - i. Provide magnetic/thermal backup for all electronic trip circuit breakers.
- G. Provide nameplates to identify switchboard and each feeder breaker by the load served.
- H. All space in each switchboard section shall be fully bussed vertically and horizontally and ready for future circuit breakers. The circuit breaker arrangements shall be arranged for maximum use of future space.
- I. Provide provisions for future bus extension for the addition of another switchboard section.
- J. Bus Composition: Tin Plated Copper. Plating shall be applied continuously to all bus work. The switchboard bussing shall be of sufficient cross-sectional area to meet UL Standard 891 temperature rise requirements. The phase and neutral through-bus shall have an ampacity as shown in the plans. For 4-wire systems, the neutral shall have 100% ampacity of the phase bus bars. Full provisions for the addition of future sections shall be provided. Bussing shall include all necessary hardware to accommodate splicing for future additions.
- K. Bus Connections: Shall be bolted with Grade 5 bolts and conical spring washers. Welded connections are not acceptable.
- L. Ground Bus: Sized per NFPA70 and UL891 Tables 25.1 and 25.2 and shall extend the entire length of the switchboard. Provisions for the addition of future sections shall be provided as outlined in Section 2.02.C.
- M. Accessibility: Accessible from the front only. Other access may be allowed if available.
- N. Equipment Ground Fault Protection (if required by NEC)

1. Main Circuit breaker(s) shall be provided with integral equipment protection for grounded systems. The circuit breaker shall be suitable for use on three phase, three wire circuits where the neutral is grounded but not carried through the switchboard, or on three phase, four wire systems.
2. The ground fault system shall include a memory circuit for positive tripping action despite intermittent arcing ground faults.
3. The ground fault sensing system shall be of the residual type.
4. Provide an integral means of testing the ground fault system to meet the on-site requirements of NEC article 230-95(c).
5. Provide a separate neutral current transformer for three phase, four wire systems where required.

O. Terminations

1. All lugs shall be UL Listed to accept solid and/or stranded copper conductors. Lugs shall be suitable for 75°C rated wire. Lug body shall be bolted in place, snap-in designs are not acceptable. Only copper conductors shall be used.
2. All circuit breakers shall be UL Listed to accept field installable/removeable mechanical type lugs.
3. All circuit breakers shall be suitable for bus connection.

2.03 POWER AND TRIP HISTORY MONITORING

A. System Description:

1. The customer monitoring shall consist of a electronic Circuit Monitor and System Display.
2. Provide a digital electronic circuit monitor, with waveform capture provisions to monitor the main circuit breaker in the service entrance switchboard. (Current metering, trip history, and switch settings)
3. Provide all necessary and required licenses, programming and set-up.

B. Circuit Monitor:

1. The electronic Circuit Monitor shall accept inputs from industry standard instrument transformers (120VAC secondary PT's and 5A secondary CT's).
2. The current and voltage signals shall be digitally sampled at a rate high enough to provide accurate RMS sensing and valid data for waveform analysis beyond the 30th harmonic (fundamental frequency of 60 HZ).
3. All setup parameters required by the Circuit Monitor shall be stored in nonvolatile memory (no battery backup) and retained in the event of a control power interruption.
4. The Circuit Monitor shall also maintain in nonvolatile memory a maximum and minimum value for each of the instantaneous values reported as well as the time and date of the highest peak for all of the peak demand readings.
5. The following instantaneous readings shall be reported by the Circuit Monitor:
 - a. Current, per phase RMS $\pm 1.0\%$
 - b. Current, 3-phase average RMS $\pm 1.0\%$
 - c. Current, apparent RMS $\pm 1.0\%$
 - d. Voltage, phase-to-phase & phase-to-neutral $\pm 1.0\%$
 - e. Power factor, per phase $\pm 2.0\%$
 - f. Power factor, 3-phase total $\pm 2.0\%$
 - g. Real power, 3-phase total $\pm 2.0\%$

- h. Reactive power, 3-phase total $\pm 2.0\%$
- i. Apparent power, 3-phase total $\pm 2.0\%$
- j. Frequency $\pm 0.5\%$
- k. Temperature $\pm 2^{\circ}\text{C}$

- 6. The following demand readings shall be reported by the Circuit Monitor:
 - a. Average demand current, per phase
 - b. Peak demand current, per phase
 - c. Average demand, KW and KVA
 - d. Predicted demand, KW and KVA
 - e. Peak demand, KW and KVA
- 7. The following energy readings shall be reported by the Circuit Monitor:
 - a. Accumulated energy
 - b. Accumulated reactive energy

C. Circuit Monitor Installation:

- 1. Electronic Circuit Monitors shall be installed by the switchboard manufacturer for the main circuit breaker of the main switchboard.
- 2. All control power, CT, PT, and communications wire shall be factory wired and harnessed within the switchboard lineup.
- 3. Where external circuit connections are required, terminal blocks shall be provided and the manufacturer's drawings must clearly identify the interconnection requirements including wire type to be used.
- 4. Provide all required hardware and software to activate the meter and permit it to be monitored from the Building HVAC Energy Management System. Coordinate all hardware and software requirements with the DDC system and provide for all licenses and interfaces necessary.
- 5. Training: Train the Owner on the use of the meter, including how to observe all readings on the meter directly and how to download the information. Coordinate the training with the DDC system installer at the same time.

D. Certification Description:

- 1. All equipment included as part of the power and trip history metering shall be UL Listed.

2.4 SURGE SUPPRESSION

- A. All switchboards shall be provided with a surge suppressor. Surge suppressor shall be externally mounted. Internally or integrally mounted surge suppression devices will not be accepted.
 - 1. All required UL Listings shall be maintained for both the switchboards and the surge suppressors.
 - 2. All warranties shall be maintained for both the switchboards and the surge suppressors.
 - 3. All National Electrical Code requirements shall be maintained for both the switchboards and the surge suppressors.
 - 4. Surge suppressors shall meet the requirements of Specification Section 26 4313.
 - 5. The switchboards and the surge suppression devices shall be submitted for approval as a package at the same time. One will not be approved without the other.

6. Provide a three pole, circuit breaker to serve the surge suppressor or provide with internal disconnect. Size breaker per surge suppressor manufacturer's recommendation.

PART 3 - EXECUTION

3.01 EXAMINATION:

- A. Examine areas and conditions under which switchboards and components are to be installed, and notify Contractor in writing of conditions detrimental to proper completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to the Installer.

3.02 INSTALLATION OF SWITCHBOARDS:

- A. Install switchboards as indicated, in accordance with manufacturer's written instructions, and with recognized industry practices; complying with applicable requirements of NEC, NEMA's Stds Pub/No. PB 2.1, and NECA's "Standard of Installation."
- B. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Stds 486 A and B, and the National Electrical Code.
- C. Install switchboard on minimum 3" high concrete pad.

3.03 FIELD QUALITY CONTROL:

- A. Prior to energization of circuitry, check all accessible connections to manufacturer's torque tightening specifications.
- B. Prior to energization of switchboards, check with ground resistance tester phase-to-phase and phase-to-ground insulation resistance levels to ensure requirements are fulfilled.
- C. Prior to energization, check switchboards for electrical continuity of circuits, and for short-circuits.

3.04 ADJUSTING AND CLEANING:

- A. Adjust operating mechanisms for free mechanical movement.
- B. Touch-up scratched or marred surfaces to match original finishes.
- C. Set all adjustable trip settings to those settings prescribed by the Coordination Study.

3.5 GROUNDING:

- A. Provide equipment grounding connections for switchboards as indicated. Tighten connections to comply with tightening torques specified in UL Std 486A to assure permanent and effective grounds. Each feeder circuit shall have a separate equipment grounding lug on a copper ground bus.

3.06 DEMONSTRATION:

- A. Subsequent to wire and cable hook-ups, energize switchboards and demonstrate functioning in accordance with requirements. Where necessary, correct malfunctioning units, and then retest to demonstrate compliance.
- B. Provide a demonstration/training session to the Owner's representatives on the operation and maintenance of the switchboard.

3.07 WARRANTY

- A. All switchboards shall be guaranteed against defective material and workmanship in accordance with the manufacturers published warranty for a minimum of one year from the date of the substantial completion. Warranty shall be published in the name of the Owner, not the contractor.

END OF SECTION 26 24 13

SECTION 26 24 16
PANELBOARDS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and other related specification sections, apply to work of this section.
- B. Division 26 Basic Electrical Materials and Methods section apply to work specified in this section.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00.
 - 1. Refer to "PART 2 – PRODUCTS" for all Buy America Build America Act (BABA) requirements.

1.03 DESCRIPTION OF WORK

- A. Extent of panelboard, load-center and enclosure work, including cabinets and cutout boxes is indicated by drawings and schedules.
- B. Types of panelboards and enclosures in this section include the following:
 - 1. Service-entrance panelboards
 - 2. Power-distribution panelboards
 - 3. Lighting and appliance panelboards
- C. Refer to other Division 26 sections for circuit breakers, cable/wire, connectors, and electrical raceway work required in conjunction with panelboards and enclosures; not work of this section.

1.04 QUALITY ASSURANCE

- A. Manufacturers: Firms regularly engaged in manufacture of panelboards and enclosures, of types, sizes, and ratings required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Installer's Qualifications: A firm with at least 3 years of successful installation experience on projects utilizing panelboards similar to that required for this project.
- C. NEC Compliance: Comply with NEC as applicable to installation of panelboards, cabinets, and cutout boxes. Comply with NEC requirements pertaining to installation of wiring and equipment in hazardous locations.
- D. UL Compliance: Comply with applicable requirements of Std No. 67 "Electric Panelboards:", and Stds No.'s 50, 869, 486A, 486B, and 1053 pertaining to panelboards, accessories and enclosures. Provide units which are UL-listed and labeled.

- E. NEMA Compliance: Comply with NEMA Stds Pub/No. 250, "Enclosures for Electrical Equipment (1000 Volts Maximum), Pub/ No. PB 1, "Panelboards", and Pub/No. PB 1.1, "Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less".
- F. Federal Specification Compliance: Comply with FS W-P-115, "Power Distribution Panel", pertaining to panelboards and accessories.

1.05 SUBMITTALS

- A. Product Data: Submit manufacturer's data on panelboards. Data must include a complete panel layout indicating the circuit breakers and corresponding circuit numbers. Include ratings of each circuit breaker including short circuit capability. Indicate all options to be supplied with the panelboard. Indicate overall panelboard bus rating and main type and rating. Show complete dimensional information. Any deviation from dimensions shown on the drawings shall be specifically pointed out in the submittal. Indicate the panelboard short circuit capacity rating. Series ratings are not acceptable.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with all of the contract documents, manufacturers offering products that meet the requirements of these specifications may be considered. The following are considered acceptable, subject to compliance with these specifications:
 - 1. Square D
 - 2. ABB
 - 3. Siemens
 - 4. Eaton
- B. All circuit breakers shall be the bolt-on type.

2.02 PANELBOARDS

- A. General: Except as otherwise indicated, provide panelboards, enclosures and ancillary components, of types, sizes, and ratings indicated, which comply with manufacturer's standard materials; design and construction in accordance with published product information; equip with proper number of unit panelboard devices as required for complete installation. Where types, sizes, or ratings are not indicated, comply with NEC, UL, and established industry standards for those applications indicated.
- B. Power Distribution Panelboards: Provide dead-front safety type power distribution panelboards as indicated, with panelboard switching and protective devices in quantities, ratings, types, and with arrangement shown; with anti-turn solderless pressure type main lug connectors approved for copper conductors. Select unit with feeder connecting at top of panel. Equip with copper bus bars with not less than 98% conductivity, and with full-sized neutral bus; provide suitable lugs on neutral bus for outgoing feeders requiring neutral connections. Provide bolt-on type molded-case main and branch circuit-breaker types for each circuit, with toggle handles that indicate when tripped. Where multiple-pole breakers are indicated, provide with common trip so overload on one pole will trip

all poles simultaneously. Provide panelboards with bare uninsulated copper grounding bars suitable for bolting to enclosures. Select flush or surface mounted type enclosures, required on the drawings, fabricated by same manufacturer as panelboards, which mate properly with panelboards.

- C. Lighting and Appliance Panelboards: Provide dead-front safety type lighting and appliance panelboards as indicated, with switching and protective devices in quantities, ratings, types, and arrangements shown; with anti-burn solderless pressure type lug connectors approved for copper conductors; construct unit for connecting feeders at top of panel; equip with copper bus bars, full-sized neutral bar, with bolt-in type heavy-duty, quick-make, quick-break, single-pole or multi-pole circuit-breakers, with toggle handles that indicate when tripped. Provide suitable lugs on neutral bus for each outgoing feeder required; provide bare copper uninsulated grounding bars suitable for bolting to enclosures. Select enclosures fabricated by same manufacturer as panelboards, which mate properly with panelboards. Loadcenters are not acceptable.
- D. Panelboard Enclosures: Provide galvanized sheet steel cabinet type enclosures, in sizes and NEMA types as indicated, code-gage, minimum 16-gage thickness. Construct with multiple knockouts and wiring gutters. Provide fronts with wire gutters and without multiple knockouts. Provide fronts with adjustable trim clamps, doors with flush locks and keys, all panelboard enclosures keyed alike, with concealed piano door hinges. Equip with interior circuit-directory frame, and card with clear plastic covering. Provide baked gray enamel finish over a rust inhibitor coating. Design enclosures for flush recessed or surface mounting, as indicated on the drawings. Provide enclosures which are fabricated by same manufacturer as panelboards, which mate properly with panelboards to be enclosed.
- E. Panelboard Accessories: Provide panelboard accessories and devices including, but not necessarily limited to, cartridge and plug time-delay type fuses, circuit-breakers, ground-fault protection units, etc., as recommended by panelboard manufacturer for ratings and applications indicated. All panelboards shall be provided with a separate copper ground bus bar.
- F. Panelboard Ratings: All panelboards shall be fully rated for the short circuit current indicated or the specific rating specified on the panel schedule, whichever is greater.
- G. Surge Suppression: Provide externally mounted surge suppressor.
 - 1. In all cases, the panelboards and the surge suppression devices shall be submitted for approval as a package at the same time. One will not be approved without the other.
 - 2. Coordinate requirements for connection with the surge suppression specification section. Provide a three pole, 30 amp (or 30 amp if TVSS call for 30 amp) circuit breaker to serve the surge suppressor.
 - 3. Internally mounted or integrally mounted surge suppression devices are not acceptable and will not be accepted.
- H. Non-linear load type panelboards (computer grade)
 - 1. Provide panels with a 200% rated neutral for all panels indicated on the drawings to be computer grade or non-linear load rated type. Panel shall be specifically labeled "computer grade" or "non-linear load rated" or similar designation. All panels served via a K-13 rated transformer shall be non-linear load rated.

PART 3 - EXECUTION

3.01 INSPECTION

- A. Installer must examine areas and conditions under which panelboards and enclosures are to be installed, and notify Contractor in writing of conditions detrimental to proper completion of work. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

3.02 INSTALLATION OF PANELBOARDS

- A. General: Install panelboards and enclosures as indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC standards and NECA's "Standard of Installation", and in compliance with recognized industry practices, to ensure that products comply with requirements.
- B. Coordinate installation of panelboards and enclosures with cable and raceway installation work.
- C. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Stds 486A and B.
- D. Anchor enclosures firmly and securely to walls and structural surfaces, ensuring that they are permanently and mechanically secure and plumb.
- E. Provide properly wired electrical connections within enclosures.
- F. Provide typewritten circuit directory card in panel door upon completion of installation work.
- G. Where panels are mounted flush in the wall, a minimum of three (3) spare 3/4" conduit shall be installed stubbed out a minimum of eight (8) inches above ceiling.

3.03 GROUNDING

- A. Provide equipment grounding connections for panelboards as indicated. Tighten connections to comply with tightening torques specified in UL Stds 486A and B to assure permanent and effective grounds.

3.04 FIELD QUALITY CONTROL

- A. Prior to energization of circuitry, check all accessible connections to manufacturer's tightening torque specifications.
- B. Prior to energization of panelboards, check with ground resistance tester phase-to-phase and phase-to-ground insulation resistance levels to ensure requirements are fulfilled.
- C. Prior to energization, check panelboards for electrical continuity of circuits for short-circuits.

- D. Subsequent to wire and cable hook-ups, energize panelboards and demonstrate functioning in accordance with requirements. Where necessary, correct malfunctioning units, and then retest to demonstrate compliance.
- E. Prior to final acceptance completely fill out the circuit directories accurately depicting the equipment connected to each circuit. Circuit directories shall be typewritten. Handwritten is not acceptable.

3.05 WARRANTY

- A. All panelboards shall be guaranteed against defective material and workmanship in accordance with the manufacturers published warranty for a minimum of one year from the date of the substantial completion. Warranty shall be published in the name of the Owner, not the contractor.

END OF SECTION 26 24 16

SECTION 26 26 00
POWER DISTRIBUTION UNIT FOR UNINTERRUPTIBLE POWER SYSTEM

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions sections, apply to work of this section.
- B. Division-26 Basic Electrical Materials and Methods sections apply to work specified in this section.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00.
 - 1. Refer to "PART 2 – PRODUCTS" for all Buy America Build America Act (BABA) requirements.

1.03 SUMMARY

- A. These specifications describe requirements for a complete power conditioning and distribution system, supplying computer grade power to sensitive loads. The specified system shall provide isolation, distribution, control and monitoring of AC power. It shall include all equipment to properly interface the AC power source to the intended load. Provide all required interface and coordination with the uninterruptible power supply.

1.04 STANDARDS

- A. The specified system shall be designed, manufactured, tested and installed in compliance with:
 - 1. American National Standards Institute (ANSI)
 - 2. Canadian Standards Association (CSA)
 - 3. Department of Energy (DOE)
 - 4. Federal Information Processing Standards Publication 94 (FIPS Pub 94)
 - 5. Institute of Electrical and Electronics Engineers (IEEE)
 - 6. ISO 9001
 - 7. National Electrical Code (NEC - NFPA 70)
 - 8. National Electrical Manufacturers Association (NEMA)
 - 9. National Fire Protection Association (NFPA 75)
 - 10. Underwriters Laboratories (UL)
- B. The system shall be UL listed as a complete system under UL 60950 Standard for Information Technology Equipment.
- C. The specified system shall comply with latest FCC Part 15 EMI emission limits for Class A computing devices and the emission and immunity limits of EN50081-2/EN55022 Class A and EN50082-2.
- D. The system shall safely withstand without misoperation or damage:

1. Transient voltage surges on the AC power input as defined by ANSI/IEEE C62.41 for Category B3 locations (high surge exposure industrial and commercial facilities),
2. Electrostatic discharges (ESD) up to 10kV at any point on the exterior of the unit and
3. Electromagnetic fields from portable transmitters within 3 ft. (1m) of the unit.

1.05 SYSTEM DESCRIPTION

A. Electrical Requirements

1. Output capacity shall be 300kVA.
2. Input voltage shall be 480 volts AC, 60 Hz, three-phase, three-wire-plus-ground.
3. Output voltage shall be 208/120 volts AC, three-phase, four-wire-plus-ground, wye configuration.

B. Environmental Requirements

1. Storage temperature range: -67 to +185°F (-55 to +85°C).
2. Operating temperature range: +32 to 104°F (0 to 40°C).
3. Relative humidity: 0% to 95% without condensing.
4. Operating altitude: Up to 6,600 ft. (2,000m) above Mean Sea Level. Derated for higher altitude applications.
5. Storage/transport: Up to 40,000 ft. (12,200m) above Mean Sea Level.
6. Audible noise level: Under normal operation noise level shall not exceed the NEMA ST-20 standard for transformers.

1.06 DOCUMENTATION

A. Equipment Manual

1. The manufacturer shall furnish an installation manual with installation, startup, operation and maintenance instructions for the specified system.

B. Drawings

1. Wiring diagrams and drawings of major components shall be furnished.

C. Spare Parts

1. A list of recommended spare parts shall be supplied at the customer's request.

D. User's List

1. An in-service user's list shall be furnished upon request.

1.07 WARRANTY

- ##### A.
- The manufacturer shall provide a one-year warranty against defects in material and workmanship for 12 months after initial startup or 18 months after ship date, whichever occurs first. Refer to the Warranty Statement for details.

B. Warranty - End User

1. All warranties associated with the UPS shall be passed through to the end user/owner (Florida Department of Transportation).

1.08 QUALITY ASSURANCE

- A. The specified system shall be factory-tested before shipment. Testing shall include, but shall not be limited to: Quality Control Checks, "Hi-Pot" Test (two times rated voltage plus 1000 volts, per UL requirements) and Metering Calibration Tests. The system shall be designed and manufactured according to world class quality standards. The manufacturer shall be ISO 9001 certified.

1.09 SUBMITTALS

1.09.1 SHOP DRAWING SUBMITTALS

- A. Submittals shall include:
 1. System configuration with single-line diagrams.
 2. Functional relationship of equipment including weights, dimensions, and heat dissipation.
 3. Descriptions of equipment to be furnished, including ANY AND ALL deviations from these specifications.
 4. Size and weight of shipping units to be handled by contractor.
 5. Detailed layouts of customer power and control connections.
 6. Interconnect wiring diagrams showing conduit wiring with terminal numbers for each wire.
 7. Descriptive list of site services and maintenance to be offered.

1.09.2 DELIVERY SUBMITTALS

- A. Submittals upon delivery shall include:
 1. A complete set of submittal drawings.
 2. Two (2) sets of instruction manuals. Manuals shall include a functional description of the equipment, safety precautions, instructions, step-by-step operating procedures and routine maintenance guidelines, including illustrations.
 3. Descriptive list of site services and maintenance to be offered.

PART 2 - PRODUCT

2.01 COMPONENTS

- A. Frame Construction and Enclosure
 1. The frame shall be constructed of welded steel to provide a strong substructure. The enclosure shall be mounted on heavy-duty swivel casters for portability and ease of installation and shall be provided with permanent leveling jacks for final installation. The unit shall have easily removable input and output cable trays. All installation and service shall be capable of being performed with access to the front only. Retrofitting additional power distribution cables shall require access to the front of the unit only. A tool shall be required to remove the exterior panels, which access the hazardous voltage area of the unit. To ensure grounding integrity and for static protection and EMI/RFI shielding, the removable exterior panels shall be grounded to the frame by way of stranded copper wire. Hinged

front doors shall provide access to the main input circuit breaker, panelboard main breaker and to all output circuit breakers. The color of the exterior panels shall be the manufacturer's standard color, black gray matte. Optional custom-painting to match or accent the data processing equipment is available.

2. The unit shall be naturally convection-cooled. No fans for forced-air cooling system shall be used. The convection cooling method shall allow continuous full-load operation without activation of over-temperature circuits. Heat rejection shall be through a screened protective top, which prohibits entry of foreign material.
3. The complete system dimensions for 150 to 300kVA units shall be a maximum of 86 in. wide by 77 in. high by 32 in. deep. The distributed floor weight shall be less than 250 lb./sq.ft..

B. Input Power Connections

1. Copper bus bars for 2-hole lugs shall be provided on the line side terminals of the main input circuit breaker for connection of the input power conductors. A copper ground bus bar shall be provided for connection of a parity-sized insulated ground conductor.

C. Main Input Circuit Breaker

1. The specified unit shall be equipped with a main input circuit breaker to provide overcurrent protection and a means for disconnecting all power to the unit. The main input circuit breaker shall be a three-pole molded case circuit breaker sized for 125% of the specified full load input current and rated for 600 VAC. The minimum UL-listed interrupting rating for the main input circuit breaker shall be 65,000 RMS symmetrical amperes at 480 volts AC. The main input circuit breaker shall include a 24 VDC shunt trip mechanism to interface with unit controls, EPO buttons and other remote controls as required by the NEC and local codes. Breaker shall be provided with electronic adjustable trip unit with adjustable long time, short time and instantaneous trips.

D. Isolation Transformer

1. The unit shall contain an electrostatically shielded isolation transformer with a rating as described in Section 1.3. The transformer shall be a dry-type, double-shielded, three-phase, common-core, convection air-cooled transformer. The transformer shall conform to UL1561, with 150°C maximum temperature rise. All transformer windings shall be copper. The transformer shall be energy efficient and meet DOE standards TP-1 2016.
2. The transformer shall exhibit the following characteristics in addition to Table 1: common mode noise attenuation, 120 dB; harmonic voltage distortion, 0.5% maximum additive.

Table 1 Standard Transformer Characteristics

kVA	Percent Impedance	Full Load Efficiency
300kVA	4.6%	98.40%

3. (The 150 to 300kVA isolation transformers shall be provided with six full-capacity compensation taps at 2-1/2% increments to accommodate field adjustment to match the source voltage. Tap changes include: two above nominal

voltage (upper range limit of +5%) and four below nominal voltage (lower range limit of -10%).) (The 800kVA isolation transformer shall be provided with four full-capacity compensation taps at 3.5% increments to accommodate field adjustment to match the source voltage. Tap changes include: two above nominal voltage (upper range limit of +7%) and two below nominal voltage (lower range limit of -7%).) These compensation taps shall be easily accessible by removing an accent panel.

4. The unit shall be provided with additional thermal overload protection for the transformer. An alarm shall notify personnel if the transformer temperature reaches 180°C. The unit shall automatically shut down if the transformer temperature reaches 200°C. Temperature sensors shall be located in each coil of the three-phase windings.

E. Manual Restart

1. The specified unit shall be equipped with a manual restart feature to allow for an orderly supervised startup after power failure. The control circuit shall automatically energize the shunt trip mechanism of the main input breaker upon sensing output voltage failure. A field-selectable auto-restart mode shall be provided to deactivate the manual restart if desired.

F. Emergency Power Off (EPO)

1. The local EPO shall include a covered Emergency Power Off (EPO) push button. Pressing the EPO switch shall immediately shut down the unit by activating the shunt trip of the main input circuit breaker. As part of the EPO circuit, an interface shall also be provided for connecting one or more normally open or normally closed remote EPO switches to the EPO circuit. For flexibility in meeting shutdown control schemes, the local EPO (unit shutdown) circuit shall be isolated from the remote EPO (room shutdown) circuit. The remote EPO circuit shall be designed to allow direct connection of multiple units with single and multiple shutdown control contacts.

G. Computer-Grade Ground

1. The specified system shall include a computer-grade, single-point ground in accordance with computer manufacturer's recommendations, IEEE Std. 1100 and the requirements of the NEC. The transformer output neutral shall be solidly grounded in accordance with NEC article 250-26. Grounding conductors shall be sized in accordance with IEC 364-HD-384 and applicable national and local codes.

H. Output Distribution Panelboards

1. The system shall contain one vertically mounted output Square D I-Line single row panelboard for distribution to the intended loads. The output distribution panelboard shall be individually protected by a 100% rated main panelboard circuit breaker. The panelboard shall be totally enclosed with an accent panel that provides access to the panelboard. The panelboard shall have a rating of 1200 amperes. The panelboard shall provide space for a total of eleven 250A frame or eight 400A LA frame or six 400A LI frame three-pole branch circuit breaker. Provide the breakers indicated on the power riser diagram, with the rest remaining as space for future breakers.

2. The output distribution section shall be of dead-front construction, with fillers plates provided for unused circuit breaker positions. The panelboard shall employ copper bus bars and be capable of accepting plug-in type circuit breakers.
3. Each panelboard shall include separate isolated neutral and safety-ground bus bars for the output neutral and safety-ground connections. The neutral bus bar and wiring shall be sized for at least 1.73 times the panelboard full load rating to accommodate high harmonic neutral currents.
4. Panelboard shall have removable output cable landing trays.

2.02 POWER MONITORING SYSTEM

A. The specified system shall be equipped with a microprocessor-based power monitor panel. The monitor panel shall gather and process information from electrical and environmental sensors, relays and switches both internal and external to the unit. The monitored parameters and alarms shall be displayed on the unit monitor panel and shall also be available for communication to a centralized monitoring system using a two-wire, twisted-pair, low-voltage signal circuit for reliable communication up to 1000 meters. The monitoring system shall be equipped with an DB-9 setup port for adjusting parameters and performing diagnostics. Three ports shall be provided to allow communication to remote monitoring systems.

B. Monitored Parameters

1. The monitoring system shall monitor and display all of the following parameters:
 - a. Input Voltage, Line-to-Line for all three phases
 - b. Output Voltages, Line-to-Line for all three phases
 - c. Output Voltages, Line-to-Neutral for all three phases
 - d. Output Voltage Total Harmonic Distortion (THD) for all three phases
 - e. Output Current for all three phases
 - f. Output Current Total Harmonic Distortion (THD) for all three phases
 - g. Output Current Crest Factor (Peak/RMS) for all three phases
 - h. Output Current Harmonic K-Factor for all three phases
 - i. Output Neutral Current
 - j. System Ground Current
 - k. Output Frequency
 - l. Output kVA
 - m. Output kW
 - n. Output Power Factor
 - o. Output kW-Hours
 - p. Percent Load
 - q. Date
 - r. Time
2. All three phases of the three-phase parameters shall be displayed simultaneously. All voltage and current parameters shall be monitored using true RMS measurements for accurate representation of non-sinusoidal waveforms typical of computers and other sensitive loads.

C. Alarm Annunciation

1. The monitoring system shall detect and annunciate by audible alarm and alarm message the following conditions:
 - a. Output Overvoltage
 - b. Output Undervoltage

- c. Output Overcurrent
- d. Neutral Overcurrent
- e. Ground Overcurrent
- f. Output Voltage Distortion
- g. Frequency Deviation
- h. Phase Sequence Error
- i. Phase Loss
- j. Transformer Overtemp

2. All alarm thresholds for monitored parameters shall be adjustable by way of the DB9 Setup port to match site requirements. The factory setpoints for the alarms shall be as follows:

- a. Output Overvoltage - voltage exceeds +6% of nominal
- b. Output Undervoltage - voltage falls below -13% of nominal
- c. Output Overcurrent - current exceeds 95% of full load amps
- d. Neutral Overcurrent - current exceeds 95% of full load amps
- e. Ground Overcurrent - current exceeds (10A for 150-225kVA), (15A @ 300kVA), (20A @ 430kVA), (25A @ 800kVA)
- f. Output Voltage Distortion - output voltage THD exceeds 10%
- g. Frequency Deviation - output frequency exceeds $\pm 0.5\text{Hz}$ of nominal

3. To facilitate troubleshooting, all alarms shall be stored in battery-backed (non-volatile) memory until reset to protect against erasure by a power outage. Alarms shall be able to be manually reset after the alarm condition has been corrected either at the unit or by way of the central monitoring system.

D. Custom Alarm Annunciation

1. The monitoring system shall be capable of providing alarm annunciation for up to five contact closures (4 N.O. and one N.C.). A custom alarm message up to 20 characters shall be provided for each contact. Alarm messages shall be programmable by way of the DB-9 setup port to match site requirements.

E. Summary Alarm Contact

1. A Form C (1 N.O. and 1 N.C.) Summary Alarm Contact shall be provided for remote alarm status. The contacts shall change state upon occurrence of any alarm and shall rest upon alarm silence.

F. Display

- 1. All monitored parameters and alarm messages shall be displayed on a monochrome Liquid Crystal Display (LCD) with oval bezel that includes a covered Emergency Power Off (EPO) switch, power and alarm LEDs, an audible alarm and an alarm silence/reset push button. The display shall be mounted on the front door, the display and switches are accessible without opening the door.
- 2. The Alarm Silence switch shall be used to silence the audible alarm and reset inactive alarms.

2.03 ACCESSORIES (OPTIONAL COMPONENTS)

A. Input Lightning/Surge Arrester

1. The specified unit shall be equipped with a secondary-class surge arrester to divert high-voltage input power surges quickly and safely to ground. The surge arrester shall be mounted ahead of all electrical components to provide maximum protection of the unit insulation and wiring. The surge arrester shall be capable of repeated operations. It shall consist of utility-grade metal-oxide varistors rated for up to 20,000 amps of surge current. The surge arrester shall be rated for maximum FOW sparkover of 3200 volts with maximum discharge voltage of 2.2kV at 1500 amperes, assuming a standard 8 x 20 microsecond waveform.

B. Output Surge Suppression Module

1. The unit shall be equipped with a surge suppression module to eliminate high-speed, high-energy transients and to filter high-frequency noise. The surge suppression module shall be mounted on the output of the unit. The surge suppressor components shall be UL recognized.
2. The surge suppressor shall utilize high-energy Metal Oxide Varistors (MOV) with a response time of less than 1 nanosecond. The clipping level shall be 212 volts on a system with a nominal peak line voltage of 170 volts and 354 volts on a system with a nominal peak line voltage of 340 volts. Peak current handling capability shall be at least 13,000 amperes based on an 8 x 20 microsecond waveform. Energy absorption capability shall be at least 200 joules per phase.
3. A passive filter, utilizing metalized polypropylene film capacitors, shall provide normal mode noise attenuation of at least 20 dB from 10kHz to 1 MHz. The capacitors shall be equipped with an integral pressure-sensitive interrupter to provide short-circuit current interrupting capability of up to 10,000 amperes at 600VAC.

C. Output Surge Suppression

1. The unit shall be equipped with a high-energy, UL1449 and UL1283 listed Transient Voltage Surge Suppression (TVSS) module connected to the unit output with minimal interconnecting wiring for maximum surge suppression. The TVSS shall consist of multiple, gapless Metal Oxide Varistor (MOV) arrays with their clamping voltages matched to within 1%. Each MOV shall be individually fused to protect against MOV failure while still allowing maximum rated surge current to flow without fuse operation. The fuses shall have a 100 kA interrupting capacity. Each array shall be capable of withstanding at least 1250 IEEE C62.41 category C3 surges (20kV, 10kA) without failure. The complete TVSS module shall have a total surge current capacity of 80kA per phase based on a standard 8 x 20 microsecond surge waveform. The UL1449 surge clamping rating shall not exceed 400 volts for a 120/208 volt system. The maximum continuous operating voltage shall be at least 150 VAC for a 120/208 volt system. The TVSS shall also provide electrical noise attenuation of 25 dB from 100 kHz to 100 MHz (based on MIL220A and 50 OHM impedance). An alarm contact of the TVSS module shall be connected to the unit monitoring system to annunciate any TVSS failure.

D. Transformer High-Temperature Alarm

1. The transformer high-temperature shutdown sensors shall be connected to provide a Transformer Hightemp alarm instead of automatically shutting down the unit when temperature reaches 392°F (200°C). Temperature sensors shall be located in each coil of the three-phase windings. The NC contact of the Temperature sensors shall be connected to Power Monitoring Panel Customer Alarm Number 5 and shall annunciate a Transformer Hightemp alarm.

E. Circuit Breakers

1. Three-pole circuit breakers shall be provided (100) (125) (150) (175) (225) (250) (300) (350) (400)*A . The fault current withstand rating for the circuit breakers shall be 65,000 AIC.

** Total of eleven 100-250A or eight 300-400A LA frame or six 300-400A LI rated breakers can be specified. The total number of breakers depends on the quantity and frame size of the breakers.*

F. Remote Emergency Power Off (REPO) Switches

1. Provisions shall be available for adding multiple REPO switches to meet specific site needs and local codes. The REPO switch shall activate the shunt trip of the main input circuit breaker to shut down the system. Each REPO switch shall be a covered, normally open, switch in a wall box. The REPO switch shall have 250 feet of 3-conductor cable to connect to the specified system.

G. Emergency Power Off (EPO) Button Deduct

1. Deduct the local EPO button from the monitoring bezel. An interface shall be provided to connecting one or more Normally Open or Normally Closed remote EPO switches which can be used to remotely shunt trip the main input breaker.

H. Distribution Monitoring

1. Monitor the current and voltage of the panelboard main circuit breaker. These measurements are used for reporting the average RMS current, power and other parameters. Reports alarm and status conditions for each panelboard main circuit breaker.
2. Monitor and display the following parameters for the panelboard main circuit breaker:
 - a. Phase Current
 - b. Percent Load
 - c. kW
 - d. kW-Hours
 - e. Voltage
 - aa. Line-to-Line
 - bb. Line-to-Neutral
 - f. Neutral Current
 - g. Ground Current
 - h. kVA
 - i. Power Factor
 - j. Voltage Total Harmonic Distortion (THD)
 - k. Current Total Harmonic Distortion (THD)
 - l. Crest Factor
3. Circuit identification and status of each breaker shall be displayed.
4. Detect and annunciate by alarm message the following conditions for each panelboard main breaker:
 - a. Overvoltage
 - b. Undervoltage
 - c. Neutral Overcurrent

- d. Ground Overcurrent
 - e. Phase Overcurrent
 - f. Phase Overcurrent Warning
 - g. Summary Alarm
5. All alarm thresholds for monitored parameters shall be adjustable by using a DB-9 setup port to match site requirements. The factory set points for the alarms shall be as follows:
- a. Overvoltage—at least one of the line-to-line voltages exceeds +6% of nominal
 - b. Undervoltage—at least one of the line-to-line or line-to-neutral voltages falls below -13% of nominal
 - c. Phase Overcurrent Warning—current exceeds 75% of breaker amps
 - d. Phase Overcurrent—current exceeds 80% of breaker amps
 - e. Neutral Current—current exceeds 95% of breaker amps
 - f. Ground Current—current exceeds (10A for 150 to 225kVA), (15A @ 300kVA), (20A @ 430kVA), (25A @ 800kVA)
 - g. Summary Alarm
Summary Alarm - shall detect and annunciate upon occurrence of any alarm
To facilitate troubleshooting, all alarms shall be stored in non-volatile memory to protect against erasure by a power outage. Alarms shall be manually reset after the alarm condition has been corrected. Alarms can be reset through the display or remotely.
 - h. Communication
Provide for future expansion of communications for added customer connections to a Building Management System (BMS) or monitoring interface.

I. Output Breaker Monitoring

- 1. Provide current transformer kits to monitor output circuit breakers rated 250A, and 300A. The system shall monitor the three phases, neutral and ground of each output circuit breaker.
- 2. The Output Breaker Monitoring shall monitor and display the following parameters for each output circuit breaker:
 - a. Phase Current
 - b. Percent Load
 - c. kW
 - d. kW-Hours
 - e. Voltage
 - aa. Line-to-Line
 - bb. Line-to-Neutral
 - f. Neutral Current
 - g. Ground Current
 - h. kVA
 - i. Power Factor
 - j. Voltage Total Harmonic Distortion (THD)
 - k. Current Total Harmonic Distortion (THD)
 - l. Crest Factor
- 3. Circuit identification and status of each breaker shall be displayed.

4. The monitoring shall detect and annunciate by alarm message the following conditions:
 - a. Neutral Overcurrent
 - b. Ground Overcurrent
 - c. Phase Overcurrent
 - d. Phase Overcurrent Warning
 - e. Summary Alarm
5. All alarm thresholds for monitored parameters shall be adjustable by way of the DB9 setup port to match site requirements.
6. Summary Alarm
Summary Alarm - shall detect and annunciate upon occurrence of any alarm. To facilitate troubleshooting, all alarms shall be stored in non-volatile memory to protect against erasure by a power outage. Alarms shall be manually reset after the alarm condition has been corrected. Alarms can be reset remotely or via the display.
7. Communication
The Output Breaker Monitoring shall communicate remotely.

J. Interface Card

1. Supply cards for remote communication using two of the following protocols: HTTP/HTTPS, Email, SMS, SNMP v1/v2c/v3, BACnet IP/MSTP and Modbus TCP/RTU output. A serial RS-485 two wire connector shall be supplied. *Note: Two of the 3rd party protocols (SNMP, Modbus or BACnet) may be configured and used simultaneously. Modbus RTU and BACnet MSTP cannot both be enabled simultaneously.*

K. Monitoring Interface

1. Provide monitoring interface module to allow to communications to computer interface. The interface module shall include software and graphics that supports up to 16 breakers using an Ethernet connection.

L. Certified Test Report

1. A certified copy of the factory test report shall be provided for each unit.

M. Factory Witness Test

1. The owner and/or the owner's representative shall be permitted to witness the factory test of each unit. The factory shall perform its standard witness test to demonstrate that the unit meets the specifications.

N. Export Crating

1. Heavy-duty solid wood crating shall be provided to meet international requirements regarding package strength and special markings for overseas shipments.

PART 3 - EXECUTION

3.01 MANUFACTURERS FIELD SERVICE

- A. Factory startup, preventive maintenance and full service for the specified system shall be available and included upon request. The manufacturer shall directly employ a nationwide service organization of factory-trained field service personnel dedicated to the startup, maintenance and repair of the manufacturer's power equipment. The manufacturer shall maintain a national dispatch center 24 hours per day, 365 days per year, to minimize service response time and to maximize availability of qualified service personnel.
- B. Perform a complete commissioning process and functional, operational testing together with the generators, transfer switches and paralleling switchgear. Make all required adjustments for a satisfactorily functioning system. Provide up to 5 days of on-site technician assistance and attendance for commissioning, testing and start-up.

END OF SECTION 26 26 00

SECTION 26 27 26
WIRING DEVICES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and other related Specification sections, apply to work of this section.
- B. This section is a Division-26 Basic Electrical Materials and Methods section, and is part of each Division-26 section making reference to wiring devices specified herein.
- C. Refer to section 26 09 23 Lighting Control Devices for coordination of low voltage lighting controls.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00.
 - 1. Refer to "PART 2 – PRODUCTS" for all Buy America Build America Act (BABA) requirements.

1.03 DESCRIPTION OF WORK

- A. The extent of wiring device work is indicated by drawings and schedules. Wiring devices are defined as single discrete units of electrical distribution systems which are intended to carry but not utilize electric energy.
- B. Types of electrical wiring devices in this section include the following:
 - 1. Receptacles
 - 2. Ground-fault circuit interrupters
 - 3. Line voltage switches
 - 4. Wallplates
 - 5. Plugs and connectors

1.04 QUALITY ASSURANCE

- A. Installer's Qualifications: Firm with at least 2 years of successful installation experience on projects utilizing wiring devices similar to those required for this project.
- B. NEC Compliance: Comply with NEC as applicable to installation and wiring of electrical wiring devices.
- C. UL Compliance: Comply with applicable requirements of UL 20, 486A, 498, and 943 pertaining to installation of wiring devices. Provide wiring devices which are UL-listed and labeled.
- D. IEEE Compliance: Comply with applicable requirements of IEEE Std 241, "Recommended Practice for Electric Power Systems in Commercial Buildings", pertaining to electrical wiring systems.

- E. NEMA Compliance: Comply with applicable portions of NEMA Stds Pub/No. WD 1, "General-Purpose Wiring Devices", WD 2, "Semiconductor Dimmers for Incandescent Lamps", and WD 5, "Specific,-Purpose Wiring Devices".
- F. FS Compliance: Comply FS W-C-596 (Series) and FS W-S-896 (Series) pertaining to electrical power connectors and toggle switches.

1.05 SUBMITTALS

- A. Product Data: Submit manufacturer's data on all electrical wiring devices.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with all of the contract documents, manufacturers offering products that meet the requirements of these specifications may be considered.

2.02 FABRICATED WIRING DEVICES

- A. General: Provide factory-fabricated wiring devices, in types, colors, and electrical ratings for applications indicated and which comply with NEMA Stds Pub/No. WD 1. Provide colors indicated below and brushed satin finish stainless steel coverplates, except as otherwise indicated. All color selections to be verified by Contractor with Architect-Engineer.

1. Important Note: Some areas will required specific wring device types. See below and drawings for specific requirements in these areas.
2. All coverplates shall be provided with a factory engraved label. Labels shall not be ordered until all devices and circuiting is installed and finalized. Label shall indicate the panel and circuit number. Provide for 20% more coverplates to allow for changes to labeling.

- B. Receptacles:

1. Heavy-Duty Duplex: Provide specification grade duplex receptacles, 2-pole, 3-wire, grounding, 20-amperes, 125-volts, with metal plaster ears, design for side and back wiring with spring loaded, screw activated pressure plate, with NEMA configuration 5-20R unless otherwise indicated.
2. Ground-Fault Interrupters: Provide "feed-thru" type ground-fault circuit interrupters, with heavy-duty duplex receptacles, capable of protecting connecting downstream receptacles on single circuit, and of being installed in a 2-3/4" deep outlet box without adapter, grounding type UL-rated Class A, Group 1, rated 20 amperes, 120-volts, 60 Hz; with solid-state ground-fault sensing and indication; with 5 milliamperes ground-fault trip level; equip with NEMA configuration 5-20R. Device must have a positive trip identification and reset.
3. Special Receptacles: Special configuration receptacles shall be standard NEMA plug configuration as specified on the drawings or as required. Provide heavy duty, specification grade receptacles, with black nylon face and brushed satin stainless steel cover plate.
4. Receptacle Colors:
 - a. General use (dirty power) receptacles (from Panel LDP): Gray.

- b. Computer receptacles, but not on the central UPS (adjacent to data outlets and/or any AV equipment – any receptacle connected to a computer grade panel – from Panel CDP): White.
- c. UPS Receptacles (all receptacles connected to the central UPS): Blue

C. Switches:

1. Snap: Provide general-duty flush single-pole, quiet type toggle switches, 20-amperes, 120-277 volts AC, with mounting yoke insulated from mechanism, equip with plaster ears, switch handle, and side-wired screw terminals.
2. 2-way: Provide general-duty flush double-pole AC quiet switches, 20-amperes, 120-277 volts AC, with mounting yoke insulated from mechanism, equip with plaster ears, switch handles, side-wired screw terminals, with break-off tab features, which allows wiring with separate or common feed.
3. Three-way: Provide general-duty flush 3-way AC quiet type switches, 20-amperes, 120-277 volts AC, with mounting yoke insulated from mechanism, equip with plaster ears, lock type switch handles, sidewired screw terminals, with break-off tab features, which allows wiring with separate or common feed.
4. Four-way: Provide general-duty flush 4-way AC quiet switches, 20-amperes, 120-277 volts AC, with mounting yoke insulated from mechanism, equip with plaster ears, switch handles, side-wired screw terminals, with break-off tab features, which allows wiring with separate or common feed.
5. Touch Snap: Provide soft-touch snap switches, cap able of effortless-fingertip operation; single-pole AC quiet, with lighted rocker switch handles; sidewired screw terminals for connecting copper-clad aluminum wire, 20-amperes, 120-277 volts rating. Equip with plaster ears.
6. Switches to be gray color with satin finish stainless steel coverplate.
7. Note: Most of the lighting controls shall be low voltage. Use these specification for line voltage switches only.

2.03 WIRING DEVICE ACCESSORIES

- A. Wallplates: Provide wallplates for single and combination wiring devices, of types, sizes, and with ganging and cutouts as required. Select plates which mate and match wiring devices to which attached. Construct with metal screws for securing plates to devices; screw heads colored to match finish of plates. Provide plates possessing the following additional construction features:
 1. Material and Finish: 0.04" thick, type 302 satin finished stainless steel with engraved labels.
 2. Provide stainless steel wallplates for all low voltage on/off and on/off/dimmer wall switches specified in 26 0923.
- B. Floor Service Outlets: Provide flush type floor service receptacle outlets and fittings of types and ratings indicated. Refer to the AT (Technology) drawings and associated specifications for box requirements and selections. Provide boxes, as indicated on the drawings, with 20-ampere, 125-volt, duplex (or quad) receptacle, NEMA configuration 5-20R for power, unless indicated otherwise.

PART 3 - EXECUTION

3.01 INSTALLATION OF WIRING DEVICES

- A. Install wiring devices as indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC and NECA's "Standard of Installation", and in accordance with recognized industry practices to fulfill project requirements.
- B. Coordinate with other work, including painting, electrical boxes and wiring work, as necessary to interface installation of wiring devices with other work.
- C. Install wiring devices only in electrical boxes which are clean; free from excess building materials, dirt, and debris.
- D. Install galvanized steel wallplates on any exposed surface mounted devices. Install weatherproof type covers for all devices that are exposed to the weather.
- E. Install wallplates after painting work is completed.
- F. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for wiring devices. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Stds 486A and B. Use properly scaled torque indicating hand tool.
- G. Contractor to provide ground fault protective type receptacles for any location within 6'-0" of sinks or other source of water. Feed through protection from one ground fault protected receptacle on a circuit is not acceptable.
- H. Mounting height of boxes for devices as shown on legend, unless otherwise noted on the plan. Refer to architectural drawings to avoid interferences with millwork. Where two or more devices are shown at the same location, use gang box and one face plate. Verify all device locations with Owner prior to rough-in. Exact device locations may be adjusted by the Owner to avoid interferences or for general convenience at no additional cost to the Owner.
- I. Floor boxes shall be installed flush with the slab and shall strictly follow manufacturer's installation instructions. Boxes shall be installed at right angles to the building lines and multiple boxes shall be in-line straight and even. Boxes observed to be installed crooked shall be removed and reinstalled.
- J. Set up, adjust, program and test all occupancy sensors and daylighting sensors prior to substantial completion. Make all required adjustments to location, settings, and device type if the sensors are not operating properly in the installed condition.

3.02 PROTECTION OF WALLPLATES AND RECEPTACLES

- A. Upon installation of wallplates and receptacles, advise Contractor regarding proper and cautious use of convenience outlets. At time of Substantial Completion, replace those items which have been damaged, including those burned and scored by faulty plugs.

3.03 GROUNDING

- A. Provide equipment grounding connections for wiring devices, unless otherwise indicated. Tighten connections to comply with tightening torques specified in UL Std 486 A to assure permanent and effective grounds.

3.04 TESTING

- A. Prior to circuitry, test wiring for electrical continuity, for short-circuits and for grounding. Ensure proper polarity of connections is maintained. Subsequent to energization, test wiring devices to demonstrate compliance with requirements.

3.05 WARRANTY

- A. All wiring devices shall have a minimum one year parts and labor warranty.

END OF SECTION 26 27 26

SECTION 26 28 13
FUSES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00.

1. Refer to "PART 2 – PRODUCTS" for all Buy America Build America Act (BABA) requirements.

1.03 SUMMARY

- A. Section Includes:

1. Cartridge fuses rated 600 V ac and less for use in the following:
- a. Control circuits.
 - b. Panelboards.
 - c. Switchboards.
 - d. Enclosed controllers.
 - e. Enclosed switches.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:

1. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.
- a. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
 - b. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.
2. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
3. Current-limitation curves for fuses with current-limiting characteristics.

1.05 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 01 77 00 "Closeout Procedures," and Section 01 78 23 "Operation and Maintenance Data," include the following:
 - 1. Ambient temperature adjustment information.
 - 2. Current-limitation curves for fuses with current-limiting characteristics.
 - 3. Coordination charts and tables and related data.

1.06 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.

2.02 CARTRIDGE FUSES

- A. Characteristics: NEMA FU 1, current-limiting, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.
 - 1. Type RK-1: 250 or 600-V, zero- to 600-A rating, 200 kAIC.
 - 2. Type RK-5: 250 or 600-V, zero- to 600-A rating, 200 kAIC, time delay
 - 3. Type J: 600-V, zero- to 600-A rating, 200 kAIC.
 - 4. Type L: 600-V, 601- to 6000-A rating, 200 kAIC.
- B. 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.
- C. Comply with NEMA FU 1 for cartridge fuses.
- D. Comply with NFPA 70.
- E. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

2.03 SPARE-FUSE CABINET

- A. Characteristics: Wall-mounted steel unit with full-length, recessed piano-hinged door and key-coded cam lock and pull.

1. Size: Adequate for storage of spare fuses specified with 10 percent spare capacity minimum.
2. Finish: Gray, baked enamel.
3. Identification: "SPARE FUSES" in 1-1/2-inch- high letters on exterior of door.
4. Fuse Pullers: For each size of fuse, where applicable and available, from fuse manufacturer.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.
- B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.
- C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.
- D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 FUSE APPLICATIONS

- A. Cartridge Fuses:
 1. Motor Branch Circuits: Class RK5, time delay.
 2. Other Branch Circuits: Class RK5, time delay
 3. Control Transformer Circuits: Class CC, time delay, control transformer duty.

3.03 INSTALLATION

- A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.
- B. Install spare-fuse cabinet(s) in location shown on the Drawings or as indicated in the field by Owner.

3.04 IDENTIFICATION

- A. Install labels complying with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems" and indicating fuse replacement information inside of door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION 26 28 13

SECTION 26 29 13
ACROSS-THE LINE MOTOR CONTROLLERS AND CONTACTORS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract including General and other related Specification Sections, apply to work of this section.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00.
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) requirements.

1.03 SCOPE

- A. The work, apparatus and materials which shall be furnished under these specifications and accompanying drawings shall include all items specified hereinafter and shown on the drawings. All other materials necessary for the complete installation shall be furnished and installed by the Contractor to provide complete electrical systems as indicated on the drawings and as specified herein.
- B. Coordinate all required interlocks with Division 21, 22, 23. Motor starters shall contain the necessary auxiliary contacts and control coil voltage to interface with the HVAC temperature control system and fire alarm control system.

1.04 DESCRIPTION OF WORK

- A. Extent of motor controller work is indicated by drawings and schedules. Types of motor controllers specified in this section include the following:
 - 1. Manual motor starters.
 - 2. Combination disconnect/FVNR motor starters.

1.05 QUALITY ASSURANCE

- A. Subject to compliance with all of the contract documents, manufacturers offering products that meet the requirements of these specifications may be considered.
- B. Installer's Qualifications: Firm with at least 10 years of successful installation experience on projects with electrical motor controller work similar to that required for this project.
- C. Codes and Standards:
 - 1. NEMA Compliance: Comply with applicable requirements of NEMA Standards Publications pertaining to motor controllers.
 - 2. UL Compliance and Labeling: Comply with applicable requirements of UL safety standards pertaining to motor controllers. Provide motor controllers and components which have been UL-listed and labeled.

3. NEC Compliance: Comply with applicable requirements of NEC pertaining to construction and installation of motor controllers.

1.06 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data, including specifications and installation instructions, for each type of motor controller required. Include data substantiating that materials comply with requirements.

PART 2 - PRODUCTS

2.01 INDIVIDUAL MOTOR CONTROLLERS

- A. Manual motor starters for 115 volts, single phase motors one horsepower and smaller, shall be single pole, horsepower rated switches with thermal overload units.
- B. Magnetic full voltage starters for three phase motors shall be three pole, horsepower rated, magnetically operated with three electronic type overload units. Provide Hand-Off-Auto selector switch, pilot lights to indicate starter's position (Amber - Red - Green), a minimum of two normally open and two normally closed auxiliary contacts, control power transformer fused on primary and secondary, control coil, and three electronic overload relays (not heaters) with automatic reset. Provide control power and coil voltage as required for interlock with the HVAC temperature control system and fire alarm system. Starters shall be the NEMA size indicated on the drawings but shall be a minimum size one. Electronic overload relays shall be matched with the actual motors supplied (non-electronic – heaters are not acceptable). Replace overloads as required in the field to match the motor characteristics.
- C. Combination magnetic, full voltage starters for three phase motors shall be three pole horsepower rated, magnetically operated contacts, with three electronic type overload units. A three pole horsepower rated, fusible disconnect switch shall also be included integral within the enclosure. Provide fuses sized as recommended by the motor manufacturer. Provide Hand-Off-Auto selector switch, pilot lights to indicate starter's position (Amber - Red - Green), a minimum of two normally open and two normally closed auxiliary contacts, control power transformer fused on primary and secondary, control coil, and three electronic overload relays (not heaters) with automatic reset. Provide control power and coil voltage as required for interlock with the HVAC temperature control system and fire alarm system. Starters shall be the NEMA size indicated on the drawings but shall be a minimum size one. Electronic overload relays shall be matched with the actual motors supplied (non-electronic – heaters are not acceptable). Replace overloads as required in the field to match the motor characteristics.
- D. Provide enclosure type suitable for the environment in which it is installed. Enclosure shall be interlocked so the door cannot be opened without turning the unit off. This interlock shall be capable of being defeated by properly trained personnel.
- E. All three phase starters (including starters or controllers provided with or internal to HVAC equipment) shall be provided with loss of phase/phase failure protection. Provide internal, factory mounted phase failure relay. Relay shall be adjustable from 0% - 30% over/under voltage and shall automatically reset.

PART 3 - EXECUTION

3.01 MOTOR CONTROLLERS, CONTACTORS AND ASSOCIATED CONTROLS

- A. Unless otherwise indicated, motor controllers shown on the drawings shall be furnished and installed under this section. The full load current and starting characteristics of each motor shall be verified for proper selection of motor over load devices. The Contractor shall furnish and install all steel shapes, etc., necessary for a support of all motor controllers.
- B. Unless otherwise indicated, all control devices, such as thermostats, firestats, etc., shall be installed in place and wired under other sections of the specifications. Coordinate required starter auxiliary contacts and coil voltages for a properly operational system.
- C. Motor controllers shall be installed in accordance with all applicable NEC installation requirements.

3.02 IDENTIFICATION OF EQUIPMENT

- A. Identification shall be provided for all motor controllers installed by the Contractor. Identification shall consist of white laminated plastic plates with black engraved letters.

3.03 WARRANTY

- A. All controllers and contactors shall be guaranteed against defective material and workmanship in accordance with the manufacturers published warranty for a minimum of one year from the date of the substantial completion. Warranty shall be published in the name of the Owner, not the contractor.

END OF SECTION 26 29 13

SECTION 26 32 13
ENGINE GENERATORS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and other related specification sections, apply to work of this section.
- B. Division-26 Basic Electrical Requirements apply to work specified in this section.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00.
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) requirements.

1.03 DESCRIPTION OF SYSTEM

- A. It is the intent of this specification to secure an emergency generator system that has been prototype tested, factory built, production tested, site tested, of the latest commercial design, together with all accessories necessary for a complete installation as shown on the plans and drawings and specified herein. The equipment supplied and installed shall meet the requirements of the National Electric Code and all applicable local codes and regulations. All equipment shall be new, of current production by a national firm which manufactures the generator and controls, transfer switch, and assembles the generator set as a matched unit so that there is one-source responsibility for warranty, parts, and service through a local representative with factory-trained service personnel.

1.04 SITE INSPECTION, TESTING, AND STARTUP:

- A. After the generator set has been installed it shall be tested at the site to assure they will function as specified.
- B. The generator manufacturer shall include in his quote the cost of providing a qualified Startup Technician to assist the installing contractor in commissioning and performing the on-site testing of the generator. The price shall include 1 trip and a maximum of 5 working days. Additional days shall be quoted on a per diem basis.
- C. The generator set manufacturer shall submit the on-site test procedure to the consulting engineer for approval prior to the actual testing. Included in the data submitted shall be copies of the blank test forms to be used for recording the test data.
- D. The commissioning and testing shall include a minimum of 1 day of instruction in the maintenance and operation of the equipment.
- E. The contractor shall notify the consulting engineer, operating personnel, and maintenance staff of the time and date of the on-site testing and training.

- F. Upon completion and acceptance of the generator testing, the generator manufacturer shall furnish a report, for record, of all data and readings.
- G. Instruct Owner on operation of the entire emergency power system, including transfer switches, fuel supply system, and engine-generators.

1.05 WARRANTY & MAINTENANCE

- A. The generator shall be guaranteed against defective material and workmanship in accordance with the manufacturers published warranty for one year or 2,000 hours, whichever occurs first, from the date of the site start-up and acceptance.
- B. The generator manufacturer and his distributor shall maintain a 24-hour parts and service organization with available on-site response time of not more than 2 hours. This organization shall be regularly engaged in a maintenance contract program to perform preventive maintenance and service on equipment similar to the specified. A service agreement shall be available and shall include system operation under simulated operating conditions, adjustment to the generators as required and certification in the Owner's maintenance log of repairs made and proper functioning of all systems.

1.06 DRAWINGS AND MANUALS

- A. The systems manufacturer shall provide the necessary interconnection diagrams for connecting the engine generator to all other equipment related to the emergency generator system.
- B. Electronic (PDF) format instruction manuals and record drawings shall be furnished for the engine generator sets and their accessories.

1.07 SUBMITTALS:

- A. Submittal shall include specification sheets showing all standard and optional accessories to be supplied, schematic wiring diagrams, dimension drawings, and interconnection diagrams identifying by terminal number each required interconnection between the generator set, the transfer switch, and other remote devices if included elsewhere in these specifications
- B. TESTING: To assure that the equipment has been designed and built to the highest reliability and quality standards, the manufacturer shall be responsible for design prototype tests as described herein: Components of the emergency system, such as the engine/generator set, transfer switch, and accessories shall not be subjected to prototype tests since the tests are potentially damaging. Rather, similar design prototypes which will not be sold, shall be used for these tests. All certified test results shall be supplied to the Engineer if requested. Prototype test programs shall include the requirements of NFPA-110 and the following:
 - 1. Maximum power (kw)
 - 2. Maximum starting (kva) at 35% instantaneous voltage dip.
 - 3. Alternator temperature rise by embedded thermocouple and by resistance method per NEMA MG1-22.40 and 16.40
 - 4. Governor speed regulation under steady-state and transient conditions

5. Voltage regulation and generator transient response
6. Fuel consumption at 1/4, 1/2, 3/4, and full load
7. Harmonic analysis, voltage waveform deviation, and telephone influence factor.
8. Three-phase line-to-line short circuit test.
9. Cooling air flow.
10. Torsional analysis testing to verify that the generator set is Free of harmful torsional stresses.
11. Endurance testing

1.08 OPERATION AND MAINTENANCE MANUALS

- A. Provide complete operation and maintenance manuals for the generators. The manuals shall contain record as-built drawings of the generator sets, including wiring diagrams. The manuals shall contain complete operation and maintenance procedures and parts lists.

1.09 QUALITY ASSURANCE:

- A. **Installer's Qualifications:** Firm with at least 5 years of successful installation experience on projects utilizing generator sets similar to that required for this project. Installer shall be a licensed electrician with experience installing at least three generator sets of equal size and scope. Generator set installers shall be approved and certified to install the supplied manufacturers equipment.

1.10 CODES AND STANDARDS:

- A. The engine-generator sets shall be manufactured and installed in accordance with all applicable codes and standards, including but not limited to the following:
 1. NFPA 70 - National Electrical Code (NEC).
 2. NFPA-110 - Emergency and Standby Power Systems – current edition

1.11 MANUFACTURER

- A. Subject to compliance with all of the contract documents, the following manufacturers offering products that meet the requirements of these specifications may be considered.
 1. Engine-Generator shall be manufactured by Caterpillar. Acceptable alternatives, yet still subject to full compliance with these specifications, are: Kohler and Cummins. All other manufacturers must be prior approved by official addendum. Any substitution requests shall be submitted a minimum 10 days prior to bid with a complete shop drawing submittal package for review. Substitutions will only be permitted if issued by an official addendum

- B. The manufacturer must have been in the electrical power generation business for at least twenty years, and must maintain a national service organization available twenty-four hours a day through the year, with 4 hour emergency service response time.
- C. Manufacturer products will be considered only when the following requirements have been submitted and accepted:
 - 1. A complete list of s products, with drawings and data sheets.
 - 2. Equipment and its capabilities must be a standard part of that systems current product line and must meet or exceed the capabilities of the equipment specified. Contractors are cautioned to conform to this specification so that the system provided will insure future options and priorities of the Owner with regard to the systems use.
 - 3. Provide a reference list of three (3) installations in the State of Florida, using the proposed equipment which is considered to be a standard part of that product. The reference list shall include a one (1) paragraph narrative of each site's system, as well as site name, address, phone number and contact name with title of that site person. Each site included must have been completed and on line for a minimum of three (3) months.

PART 2 - PRODUCTS

2.01 GENERAL:

- A. The standby diesel generator sets shall be rated standby power (defined as continuous operation for the duration of any power outage) 480Y/277 volts, 3 phase, 4 wire, .8 power factor, 500KW/625KVA as indicated on the drawings, at 3300 feet altitude, 104 degrees Fahrenheit. Vibration isolators shall be provided between the engine-generator and welded steel base or between the base and the slab.
 - 1. Generators shall comply with EPA/DEP regulations that apply at the time of the estimated shipping date. Provide copies of all required registrations and certifications with the project closeout documents.
- B. Final Production Tests: Each generator set shall be tested under varying loads with guards and exhaust system in place. Tests shall include:
 - 1. Single-step load pickup
 - 2. Transient and steady-state governing
 - 3. Safety shutdown device testing
 - 4. Voltage regulation
 - 5. Rated Power
 - 6. Maximum Power
- C. Upon request, arrangements to witness this test will be made or a certified test record will be sent prior to shipment.

2.02 ENGINE:

- A. The engine shall deliver a minimum of bhp at a governed speed of 1800 rpm to deliver the rated KVA/KW. The engine shall be equipped with the following:
1. Fuel shut-off valve.
 2. Electronic isochronous load sharing governor capable of +/-0.25% steady state frequency regulation over an operating range -40C to +85C.
 3. 24 volt positive engagement solenoid shift-starting motor.
 4. 40-ampere minimum automatic battery charging alternator with solid-state voltage regulation.
 5. Positive displacement, full pressure lubrication oil pump, cartridge oil filters, dipstick, and oil drain.
 6. Dry-type replaceable air cleaner elements.
 7. Engines requiring glow plugs will not be acceptable when NFPA-99 or NFPA-110 Type 10 (ten-second) transfer requirement must be met. Note: 10 second transfer must be met.
 8. The naturally aspirated or turbocharged engine shall be fueled with diesel fuel, and be liquid cooled. An appliance regulator and all associated fuel delivery accessories shall be provided with the generator. A unit-mounted radiator, blower fan, water pump, thermostat, and radiator duct flange (un-housed only) shall properly cool the engine with up to 0.5 inches H2O external static pressure on the cooling system.
 9. Engine shall be Tier IV (or most current ratings in affect for stand-by) DEP/EPA emissions approved and rated. Provide all required documentation, registrations, permits, and approvals. Provide approval and rating required at the time of shipping.

2.03 GENERATOR:

- A. The alternator shall be salient-pole, re-connectable 10 lead, of 2/3 pitch to eliminate the third harmonic, self-ventilated of drip-proof construction with amortisseur rotor windings and skewed for smooth voltage waveform. The insulation material shall meet the NEMA standard (MGI-22.40 and 16.40) for Class H and be vacuum impregnated with epoxy varnish to be fungus resistant per MIL I-24092 or be multiply dipped and baked with non-hygroscopic varnish with a final dip of epoxy. The excitation system shall be of brushless construction controlled by a solid-state voltage regulator capable of maintaining voltage within + or - 0.5% at any constant load from 0 to 100% of rating.
- B. The generator shall be capable of sustaining at least 250% of rated current for at least 10 seconds under a 3 phase symmetrical short by inherent design or by the addition of an optional current boost system.
- C. The generator, having a single maintenance free bearing, shall be directly connected to the flywheel housing with a semi-flexible coupling between the rotor and the flywheel.

- D. Gauge Panel: Set- mounted, NEMA 1 dead front, vibration isolated. Gauge panel shall include:
1. Panel illuminating lights.
 2. Battery charging voltmeter.
 3. Coolant temperature gauge.
 4. Oil pressure gauge.
 5. Running time meter.
 6. Local emergency stop button and remote EPO with required wiring.
 7. Dual element electronic speed switch with crank disconnect contact and overspeed contact shall be controlled by a magnetic pickup mounted radially to flywheel ring gear. Terminal blocks shall be provided for all engine/generator pre-alarms and safety shutdowns plus auxiliary functions for interconnect to engine/generator control cubicle. Each terminal shall be permanently marked to match the point to point wiring diagrams.
 8. Provide Remote Annunciator: Remote annunciator shall be provided and mounted in the main electrical room. Provide all required conductors and conduit. The conduit shall be a minimum of 1-1/4". Annunciator shall indicate all major generator operating conditions, alarms, and warnings, including fuel level. Remote annunciators located electrical room shall be surface mounted type.
 9. Provide all other annunciation, monitoring and control required by EPA and DEP for the fuel system.
 10. Annunciators shall provide fuel level monitoring.
 11. Provide for a network connection and communications to the building network for all annunciator data, including fuel level.

2.04 WIRING

- A. All control wiring to the dry contacts located in the transfer shall be 18 gauge stranded wire for distances up to 1000 feet.

2.05 ACCESSORIES:

- A. The following accessories shall be provided:
1. Overvoltage protection will shut down the unit after one second of 15% or more overvoltage.
 2. Battery rack, battery cables, 12-volt battery(ies) capable of delivering the minimum cold-cranking amps required at zero degrees Fahrenheit per SAE Standard J-537.

3. Gasproof, seamless, stainless steel, flexible exhaust connector(s) ending in pipe thread.
4. Flexible fuel line(s) rated 300 degrees F and 100 PSI ending in pipe thread.
5. Provide critical rated engine exhaust silencer, coated to be temperature and rust resistant, rated for critical applications. Exhaust noise shall be limited to 68 dba as measured at 10 feet in a free-field environment.
6. Block heater and jacket heater of proper wattage and 208 volts, single phase, thermostatically controlled to maintain engine coolant at 90 degrees Fahrenheit (32 degrees Celsius) to meet the start-up requirement of NFPA-99 or NFPA-110 Regulations.
7. 10-Ampere automatic float and equalize battery charger with +- 1% constant voltage regulation from no load to full load over +- 10% AC input line variation, current limited during engine cranking and short circuit conditions, temperature compensated for ambients from -40 degrees C to +60 degrees C, 5% accurate voltmeter and ammeter, fused, reverse polarity and transient protected. Battery charger shall have 120 volt input. Provide alarm circuit board to meet the requirements of NFPA-110 for low battery voltage, high battery voltage, and battery charger malfunction.
8. Break-glass type remote emergency stop stations which meet the requirements of NFPA-110. Provide required control circuit. Locate stations as indicated on the drawings.
9. Provide 180 MPH, missile impact rated and critical sound attenuated, weatherproof enclosure. Enclosure shall be provided with a full length exterior galvanized steel cat-walk on each side of the generator enclosure along the long dimension, including stairs to a level walkway at the generator height above the fuel tank that allows full access to all doors and compartments. Refer to section 2.6.
10. Provide an integral in base fuel tank sized for 7 days (168 hours) of fuel at 75% rated load. Tank shall be UL 142, double wall and shall include a leak detector, low fuel alarm and all required accessories, monitoring, alarms, and annunciation to meet EPA and DEP requirements. Tank shall be filled and topped off with fuel after testing.
 - a. Fuel tank shall be provided with available access to all compartments within the inside of tank for cleaning and applying chemical treatment. Tanks that are compartmentalized or have added structural supports that can block access to each compartment or areas of the tank will not be acceptable. Access to all areas of the tank for cleaning and chemical treatment is imperative.
11. Provide coordination with the 300 KW UPS systems and provide all necessary control (slew rate, etc.) for proper operation.
12. Provide all required coordination and controls with the automatic transfer switches.

2.06 GENERATOR ENCLOSURE:

- A. Weather Resistant type enclosure shall be provided to house the engine/generator and accessories. The enclosure is to be in complete compliance with the National Electrical Code (NEC), and the National Fire Protection Association (NFPA) with regard to clearances around electrical equipment specified herein. The enclosure shall conform to the following construction and design criteria as set forth herein.
1. - Rigidity wind test equal to 180 MPH, or as required by ASCE-7
 2. - Roof load equal to 30 lbs. per sq. ft.
 3. - Rain test equal to 4" per hour
 4. -Florida Department of Business and Professional Regulation (DBPR) Modular Building Insignia
 6. -Large Missile Impact Resistant per FBC 1626.2 Testing Requirements with Approval Numbers.
- B. Enclosure shall consist of a roof, two (2) side walls, two (2) end walls, and shall be manufactured of formed panel aluminum components. The enclosure is to be provided with a tiedown frame for securely attaching the entire structure to the concrete pad foundation as provided by the installing contractor.
- C. Roof, sidewalls and end walls shall be of formed 0.090 marine grade aluminum panel construction. The roof is to be bolted to both side and end walls to form a complete weather and wind resistance assembly.
- D. The radiator front face shall be sealed to the front wall utilizing a 2" minimum rubber gasket material to minimize recirculation of radiator air discharge and prevent the transmission of vibration from the packaged generator set to the enclosure.
- E. Wall framing shall be incorporated in the panels by forming an open back box structure. Skin material shall be minimum thickness .090" marine grade aluminum. Enclosure shall have a painted finish for maximum corrosion resistance. Exterior skin panels shall be integral to the wall structure and not separate pieces riveted onto framing members. Wall panels shall be no wider than 36" each and shall be removable without the use of special tools. Wall and roof panels shall be designed so that field replacement can be accomplished without disassembly of the entire structure if damage should occur. Provide rodent protection from entering from below or up through the fuel tank openings.
- F. A minimum of sixteen colors shall be available for enclosure exterior. Enclosure exterior color shall be WHITE unless otherwise specified.
- G. Roof assembly shall be Cambered to aid in rain runoff. Roofs with thicknesses of less than 0.090" nominally shall not be considered. Roof assemblies are to be mechanically fastened to the vertical wall sections. Glued or crimped roofs shall not be allowed nor considered as an acceptable alternative.
- H. Air handling shall be as follows: Air will enter the enclosure through a Hood, Plenum or Sound Attenuated Louvers/Baffles, as determined by the specific application and shall allow for at least 120% of total airflow demand for proper cooling to the generator set package. The cooling air Inlet system shall prevent water intrusion into the enclosure

with the generator set operating at full rated load while allowing for a maximum air restriction of less than 0.25" H₂O. Radiator discharge shall be through a gravity operated extruded aluminum backdraft type damper and into a vertical discharge plenum or hood. Discharge plenum/hood shall discharge air upward and be provided with a means to positively drain any and all water entering the discharge device. Air discharge devices shall in no event restrict airflow by more than 0.025" H₂O. To ensure adequate airflow for cooling and combustion total static restriction over the entire system shall not exceed 0.50" H₂O. Both Intake and Discharge shall be provided with removable bird/rodent screening to prevent the entrance of debris, birds, rodents and other vermin.

- I. Acoustical insulation materials shall consist of a UL Classified Thermofiber® insulation material with a heat/fire resistance rating up to 2400° F and provide superior sound attenuation performance. Acoustical insulation material on interior roof and walls is to be mechanically held in place by 0.032" mill finished perforated aluminum with tuned engineered hole diameter for optimum sound attenuation at 1000 Hz. Interior perforated aluminum material shall protect the insulation material as well as allow noise to permeate the absorptive material.
- J. Four-point lifting provisions shall be provided and have sufficient capacity suitable for rigging the entire assembly including all installed equipment.
- K. A minimum of two (2) single personnel access doors shall be provided. Doors shall be manufactured of the same material as enclosure. Doors shall be fully gasketed to form a weather tight perimeter seal. Door hinges shall be full-length stainless steel piano type and shall be attached with stainless steel hardware. Door handles shall be of a corrosion resistant material and shall provide for a lockable, secure entry point into the enclosure. Doors shall be insulated with no less insulation than is provided in the enclosure walls for sound attenuation. Drip ledges are to be provided above each entry door and shall overhang the door on both sides by a minimum of 3".
- L. Enclosure manufacturer shall provide all necessary hardware to internally or externally mount the exhaust silencer(s) specified herein. Silencer mounting hardware shall at all times maintain the Weather Resistant integrity of the enclosure system. If the silencer is mounted internally it will discharge upward into the radiator discharge plenum where possible, otherwise an aluminum rain collar and rain dress shield shall be provided by the enclosure manufacturer.
- M. As a minimum the enclosure shall provide an average 15db(A) sound reduction as measured at one meter, five feet above grade level under free field conditions.
- N. Enclosure must bear the Florida Department of Business and Professional Regulation (DBPR) Modular Building Insignia.
- O. The Enclosure Components Shall be registered with the State of Florida and Have Approval Numbers to Certify the Enclosure Capable of Meeting the Requirements of the Florida Building Code for Large Missile Impact Resistance per Testing Section 1626.2.
- P. Provide LED lighting (minimum 6 lights) with light switch at main door entrance. Wire all of the lights and the switch to a junction box at a location to be connected by the electrician on site. Also, provide a minimum of two emergency egress battery back-up type light fixtures (bug-eyes), and wiring them to the un-switched leg of the lighting circuit.

- Q. Provide a minimum of one 20 amp, 120 volt, GFI receptacle inside the generator enclosure. Receptacle shall be field wired to a circuit by the field electrician.
- R. Arrange for the exhaust muffler to exhaust in a direction free of any building air intake louvers. Provide additional piping and elbows as necessary.
- S. Provide lightning protection air terminals on all four corners of the roof of the enclosure, and provide copper horizontal and down conductors to ground rods for lightning protection on the enclosure. Bond to stairs and fuel tank. Refer to specification 26 31 13.
- T. Provide aluminum stairs, platform, and railings, on both sides of the generator enclosure for access to all doors. Provide for access to fueling and all areas of maintenance, and allow for all doors to fully open.

PART 3 - EXECUTION

3.01 EXAMINATION:

- A. Examine areas and conditions under which engine-generator and components are to be installed, and notify Contractor in writing of conditions detrimental to proper completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to the Installer.

3.02 INSTALLATION:

- A. Install generator on minimum 3" high concrete pad as indicated on structural drawings. Install vibration isolation.
- B. The equipment shall be installed as shown on the plans, in accordance with the manufacturer's recommendations and all applicable codes. Except for the required field installation, and connections, the generator sets, transfer switches, and switchgear shall be shipped to the project site as a "single source" item for which responsibility for overall maintenance, spare parts, and service is available through a local factory distributor.
- C. Site Tests: An installation check, start-up, 100% load bank test, and building load test shall be performed by the manufacturer's local representative. The engineer, regular operators, and the maintenance staff shall be notified of the time and date of the site test. The tests shall include:
 1. Fuel, lubricating oil, and antifreeze (liquid cooled models) shall be checked for conformity to the manufacturer's recommendations under the environmental conditions present and expected.
 2. Accessories that normally function while the set is standing by shall be checked prior to cranking the engine. This shall include: engine heaters, battery charger, generator strip heaters, remote annunciator, etc.
 3. Start-up under test mode to check for exhaust leaks, path of exhaust gases outside the building, cooling air flow, movement during starting and stopping, vibration during running, normal and emergency line-to-line voltage and phase rotation.
 4. Automatic start-up by means of simulated power outage to test remote-automatic starting, transfer of the load, and automatic shutdown. Prior to this test, all transfer switch timers shall be adjusted for proper systems coordination. Engine

temperature, oil pressure and battery charge level along with generator voltage, amperes, and frequency shall be monitored throughout the test.

5. Test all transfer switch and paralleling gear sequences.
 5. Assist the Owner with the registration of the fuel tank. Schedule and perform all tests required by the DEP and EPA in the presence of any required inspectors.
 6. Provide load bank for a 100% load test after installation of the generator.
 7. Test ground fault indication, if applicable.
- D. Test all monitoring and annunciation equipment and obtain all DEP/EPA permits, inspections and approvals.

END OF SECTION 26 32 13

SECTION 26 32 13.1
GENERATOR DOCKING STATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and other related specification sections, apply to work of this section.
- B. Division-26 Basic Electrical Requirements apply to work specified in this section.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00.
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) requirements.

1.03 QUALITY ASSURANCE

- A. 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.
- B. ETL/UL LISTED to 1008 Standards
- C. UL 50 LISTED

1.04 COORDINATION

- A. Coordinate layout and installation of Generator Docking Station, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels

1.05 GUARANTEE/WARRANTY

- A. Manufacturer Warranty shall be provided for a minimum of 5 Years,
 - 1. Extended Warranty will be supplied upon at user’s request at an additional charge from Manufacturer.
- B. The equipment installed under this contract shall be left in proper working order
- C. New materials and equipment shall be guaranteed against defects in composition, design or workmanship. Guarantee certificates shall be furnished.

PART 2 PRODUCTS

2.01 DOCKING STATION

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. TRYSTAR
2. ESL
3. ASCO.

2.02 GENERAL REQUIREMENTS

A. Enclosure

1. NEMA 3R Rain-Tight Aluminum Enclosure
 - a. Pad-lockable front door shall include a hinged access plate at the bottom for entry of temporary cabling that prevents unauthorized tampering while in use.
 - b. NEMA 3R Integrity shall be maintained while temporary cabling is connected during use
 - c. Front and Side shall be accessible for maintenance
 - d. Top, Side, and Bottom shall be accessible for permanent cabling
2. Powder coat
 - a. Paint after fabrication shall be Hammer tone Gray

B. Phase, Neutral, and Ground Busbar

1. Material: Silver-plated Copper
2. Equipment Ground Bus: bonded to box.
3. Ground Bus: 50% of phase size.
4. Neutral Bus: Neutral bus rated 100 percent of phase bus.

C. Temporary generator connectors shall be Camlok style mounted on gland plate.

1. Camlok shall be 16 Series model and color coded according to system voltage requirements.
2. Camlok connections shall be Bus Bar Style, Cabling or Double Set Screw is not acceptable
3. Camlok connection shall be protected against accidental contact while not in use

D. Permanent Connection shall be factory installed broad range set-screw mechanical type, located behind a physical barrier

E. Short Circuit & Withstand Rating

1. Shall be minimum 65 KAIC unless otherwise indicated on drawings

F. Voltage & Amperage

1. 480V, 800Amps

G. Factory Installed Phase Rotation Monitor Device:

1. Phase monitoring relay to be Siemens 3U4512-1AR20 or equal and factory installed

H. Additional accessories shall be included in submittal drawing as follows:

1. Two Wire Auto Start
2. Battery Charger Receptacle 20A DUPLEX 125V
3. Battery Charger Receptacle 20A GFCI 125V
4. Block Heater Receptacle 30A L5-30 125V
5. 50A Twist-Lock 125V/250V
6. SCADA Terminal Port
7. Kirk Key Door Interlock
8. Listed Monitoring Device
9. Strip Heater & Thermostat
10. Surge Protection Device
11. Load Dump Receptacle
12. Utility Light/Alarm (Customer Specified)

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine elements and surfaces to receive Generator Docking Station for compliance with installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected

3.02 INSTALLATION

- A. Surface, Flush or Base Mounted: Determined by Application
 1. Install anchor bolts to elevations required for proper attachment to Generator Docking Station.

3.03 IDENTIFICATION

- A. Comply with requirements in Division 26 Section "Identification for Electrical Systems."
- B. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
- C. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.04 FACTORY COMMISSIONING

- A. Upon completion of the installation, the docking station shall be commissioned by the Manufacturer's factory authorized technician.
- B. SCOPE OF WORK SHALL INCLUDE:
 - 1. Review and verify the installation of all docking station components and verify the correct electrical flow as depicted on the one-line drawings.
 - 2. The Manufacturer's authorized technician will set the long time, short time, instantaneous and ground fault protection settings on the Generator Docking Station circuit breaker(s) in accordance with the engineer's specifications or as provided as part of the coordination study.
 - 3. Factory training for on-site personnel to educate them on how to connect the GDS to a portable generator
 - 4. The Manufacturer's factory authorized technician shall, upon completion of the commissioning provide a written report to the electrical contractor and electrical engineer indicating the completion of the work.
 - 5. Any issue that is found during the start-up that is determined at that time to be a warranty issue will be covered by Manufacturer. Any issues that are specific to the scope for the electrical installing contractor are the sole responsibility of the installing contractor.
 - 6. Upon successful completion of the commissioning, provide a complimentary 12-month warranty extension, above and beyond the 12-month manufacturer warranty.

3.05 FIELD QUALITY CONTROL

- A. Third Party Tests and Inspections to include the following:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
- B. Prepare test and inspection reports, including a certified report that identifies Generator Docking Station and that describes scanning results.

END OF SECTION 26 32 13.1

SECTION 26 33 53
STATIC UNINTERRUPTIBLE POWER SUPPLY

PART 1 – GENERAL

1.01 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and other related specification sections, apply to work of this section.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00.
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) requirements.

1.03 SUMMARY

- A. These specifications describe requirements for an Uninterruptible Power System (UPS). The UPS shall automatically maintain AC power within specified tolerances to the critical load, without interruption, during failure or deterioration of the normal power source.
- B. The manufacturer shall design and furnish all materials and equipment to be fully compatible with electrical, environmental and space conditions at the site. It shall include all equipment to properly interface the AC power source to the intended load and shall be designed for unattended operation.

1.04 STANDARDS

- A. The UPS and all associated equipment and components shall be manufactured in accordance with the following applicable standards:
 - 1. The UPS shall be UL listed per UL Standard 1778, Fourth edition, Uninterruptible Power Supplies, and shall be CSA Certified.
 - 2. The UPS shall be provided with a Short Circuit Withstand Rating (SCWR) label denoting the maximum source fault short circuit current that is applicable to the unit. The withstand rating shall be independently verified by a nationally recognized, third-party lab.
 - 3. The UPS shall withstand input surges to both the rectifier and bypass when configured as a dual-input unit without damage per the criteria in ANSI C62.41, category B3 (6kV). The manufacturer shall provide evidence of compliance upon request.
 - 4. The UPS shall comply with FCC Rules and Regulations, Part 15, Subclass B, Class A. The UPS shall have a label stating FCC compliance. The manufacturer shall provide evidence and test data of compliance upon request.
 - 5. The UPS shall be compatible with the wiring practices, materials and coding in accordance with the requirements of the National Electrical Code, OSHA and applicable local codes and standards. Provisions shall be made in the cabinets to permit installation of input, output and external control cabling using raceway or conduit for top and bottom access to input, output, bypass and DC connections.

Connection cabinets shall provide for wiring gutter and wire bend radius as defined by the NEC and UL.

6. The UPS and battery cabinets shall be certified to the International Building Code (IBC) 2021 with seismic performance of $S_{ds}=2.27$, $I_p=1.5$ and $z/h=1.0$, Optional seismic anchorage shall be available from the UPS and battery manufacturer(s) for use in compliance with this certification. The UPS module shall be pre-certified by OSHPD.

1.05 SYSTEM DESCRIPTION

A. Design Requirements

1. The UPS shall be sized to provide a minimum of 300kVA/kW output (unity load power factor rating)
2. The UPS shall be able to supply all required power to full rated output kVA loads with power factor from 0.7 lagging to 0.9 leading.
3. Load voltage and bypass line voltage shall be 480VAC, three-phase, three-wire plus ground. Input voltage shall be 480VAC, three-phase, three-wire plus ground. The AC input source and bypass input source shall each be a solidly grounded wye service except in a high resistance ground requirement (see below).
4. The rectifier AC input and bypass AC input may be fed from separate AC sources.
5. The battery shall support the UPS at 100% rated kW load for at least 60 minutes at 77°F (25°C) at startup.
6. The UPS shall have an active power factor-corrected IGBT converter/rectifier, capable of maintaining input power factor and input current total harmonic distortion (THDi) within specifications without an additional input filter.
7. The UPS shall be of transformer-free design, requiring no internal transformer in the main power path for the basic operation of the module. Optional transformers in cabinets or otherwise external to the basic UPS module shall be permissible to provide isolation and/or voltage transformation.
8. The UPS shall be capable of operating in a High Resistance Ground environment, and shall provide notification when a fault to ground occurs on its output. Leakage current shall not exceed 1.5 amps.

B. Modes of Operation: The UPS shall operate as an on-line reverse transfer system in the following modes:

1. Normal: The critical AC load shall be continuously powered by the UPS inverter. The rectifier/charger shall derive power from the utility AC source and supply DC power to the DC-DC converter, which in turn shall supply the inverter while simultaneously float charging the battery.
2. Energy Optimization Mode (Active Eco Mode): The critical AC load shall be continuously powered by the bypass with the inverter available to power the load if the bypass source voltage or frequency exceeds adjustable parameters of power quality.
3. Emergency: Upon failure of utility AC power, the critical AC load shall be powered by the inverter, which, without any switching, shall obtain its power from the battery plant via the DC-DC converter. There shall be no interruption in power to the critical load upon failure or restoration of the utility AC source.

4. Recharge: Upon restoration of the utility AC source, the rectifier shall supply power to the output inverter and to the DC-DC converter, which shall simultaneously recharge the battery. This shall be an automatic function and shall cause no interruption to the critical AC load.
5. Bypass: If the UPS must be taken out of service for maintenance or repair, the bypass static switch shall transfer the load to the bypass source. The transfer process shall cause no interruption in power to the critical AC load. An optional external wrap-around maintenance bypass shall be used to ensure full isolation of the unit for the service of internal components while providing safety from arc flash and in compliance with OSHA requirements.
6. Off-Battery: If the battery only is taken out of service for maintenance, it shall be disconnected from the DC-DC converter by means of an external disconnect circuit breaker. The UPS shall continue to function and meet all of the specified steady-state performance criteria, except for the power outage backup time capability. If multiple battery strings are used, each string shall be capable of being electrically isolated for safety during maintenance.

C. Performance Requirements

1. The solid-state power components, magnetics, electronic devices and overcurrent protection devices shall operate within the manufacturer's recommended temperature when the UPS is operating at 100% critical load and maintain battery charging with either of the following conditions occurring:
 - a. Any altitude within the specified operating range up to 3300 ft. (1000m) elevation
 - b. Any ambient temperature within the specified operating range of 32°F to 104°F (0°C to 40°C)

D. Input

1. Voltage: Input/output voltage specifications of the UPS shall be:
 - a. Rectifier AC Input: 480V, three-phase, three-wire-plus-ground
 - b. Bypass AC Input: 480V, three-phase, three-wire-plus-ground
 - c. AC Output: 480V, three-phase, three-wire-plus-ground
2. Voltage Range: +10%, -30% of nominal (minimum -15% at nominal load.) The UPS shall operate without discharging the battery at 70% of full nominal load with voltage down to -30% of nominal.
3. Frequency Range: 60Hz, adjustable by service personnel up to ± 3.6 Hz in 0.12Hz increments
4. Rectifier Walk-In: 0% to 100% of full rated load over 2.5-90 seconds (adjustable) with full rectifier power.
5. Rectifier Start Delay: Programmable from 1-180 seconds
6. Max Inrush Current: UPS inrush current not to exceed 1.5 times rated input current.
7. Power Factor: Minimum 0.99 at full load with nominal input voltage
8. Current Distortion: Less than 3% input current THD at rated load and nominal voltage in double-conversion mode
9. Surge Protection: Sustains input surges without damage per criteria listed in ANSI C62.41, category B3 (6kV)
10. Short Circuit Current Withstand Rating: Units shall carry as standard 100 kA Short Circuit Withstand Rating (SCWR). All ratings shall be certified and a label

shall be applied to the unit clearly identifying this rating as required by the National Electrical Code.

E. AC Output

1. Load Rating: 100% load rating at 104°F (40°C) for 8 hours for any load from 0.9 leading to 0.7 lagging; 100% of load rating continuous at 95°F (35°C).
2. Voltage Regulation:
 - a. ±1% RMS average for a balanced three-phase load
 - b. ±3% for 100% unbalanced load for line-to-line imbalances
3. Voltage Adjustment Range: ±5% for line drop compensation adjustable by factory service personnel.
4. Frequency Regulation:
 - a. Synchronized to bypass: ±1.2Hz default setting, adjustable by factory service personnel)
 - b. Synchronized to internal clock 0.06Hz
5. Efficiency: Defined as output kW/input kW at rated lagging load power factor; and not less than the values listed below (select kVA rating for this specification):

kVA Rating	25% Load	50% Load	75% Load	100% Load
300	94%	95.20%	95.30%	95%

6. Phase Imbalance:
 - a. Balanced loads 120° ±1°
 - b. 100% unbalanced loads 120° ±3°
7. Voltage Transients (average of all three phases):
 - a. 0-100% or 100-0%
 Response: Meets IEC 62040-3: 2010 Figure 2 Curve 1, Class 1
 Meets ITIC and CBEMA Curve Requirements
 - b. 10-100% or 100-10%
 Transient Voltage Deviation, RMS: ≤5%
 Step Load Transient Recovery (linear loads) ±1% of nominal within four line cycles
8. Voltage Harmonic Distortion:
 - a. Maximum 1% RMS total (100% resistive load)
9. Overload at Full Output Voltage with ±1% Voltage Regulation:
 - a. 100% continuously
 - b. 125% of full load for 10 minutes at 95°F (35°C) ambient
 - c. 150% of full load for a minimum of 60 seconds at 95°F (35°C) ambient
10. Current Limit: 300% nominal current including a bolted fault condition without bypass for up to 10 milliseconds and 150% for <5 seconds.
11. Fault Clearing:
 - a. Inverter only: 200% of normal full load current for 200 milliseconds or 150% of normal full load current for <5 seconds (when bypass is not available).

- b. Bypass available: 500% for 600 milliseconds operation when bypass is available.
- c. The UPS shall supply current from both the bypass and the inverter until the inverter overload time expires, and then shall continue to supply current from the bypass to clear the fault.

F. Grounding

1. The UPS chassis shall have an equipment ground terminal. Provide all required grounding and bonding.

1.06 ENVIRONMENTAL CONDITIONS

The UPS shall be able to withstand the following environmental conditions without damage or degradation of operating characteristics:

A. Operating Ambient Temperature

1. UPS: 32°F to 104°F (0°C to 40°C) for up to 8 hours without derating; up to 95°F (35°C) continuously without derating
2. Battery: 77°F (25°C), ±5°F (±3°C)

B. Storage/Transport Ambient Temperature

1. -4°F to 158°F (-20°C to 70°C)

C. Relative Humidity

1. 0 to 95%, non-condensing

D. Altitude

1. Operating: To 3300 ft. (1000m) above Mean Sea Level without derating (compliant with IEC/EN 62040-3 at altitudes exceeding 1000m). Consult factory for derating above 3300 ft. (1500m) elevation.
2. Storage/Transport: To 50,000 ft. (15,000m) above Mean Sea Level

E. Audible Noise Level

1. 70dBA measured 5 ft. (1.5m) from the surface of the unit

1.07 SUBMITTALS

A. Proposal Submittals

Submittals with the proposal shall include:

1. Descriptions of equipment to be furnished, including deviations from these specifications.
2. Document stating compliance with FCC requirements.
3. Document stating listing to UL, including edition used for listing.
4. Document showing compliance with required SCCR and labeling.
5. System configuration with single-line diagrams.
6. Detailed layouts of customer power and control connections.

7. Functional relationship of equipment, including weights, dimensions and heat dissipation.
8. Information to allow distribution system coordination.
9. Size and weight of shipping units to be handled by contractor.

B. Order Submittals

Submittals produced for the order shall include:

1. All of the documentation presented with the proposal, per Section 1.5.1 above.
2. Detailed installation drawings including all terminal locations.
3. Interconnect wiring diagrams showing conduit wiring with terminal numbers for each wire.

C. UPS Delivery Submittals

Submittals upon UPS delivery shall include:

1. A complete set of submittal drawings.
2. Two sets of instruction manuals. Manuals shall include a functional description of the equipment, safety precautions, instructions, step-by-step operating procedures and routine maintenance guidelines, including illustrations.

1.08 WARRANTY

A. UPS Warranty

1. The UPS manufacturer shall warrant the unit against defects in workmanship and materials for 12 months after initial startup or 18 months after the shipping date, whichever comes first.

B. Warranty - End User

1. All warranties associated with the UPS shall be passed through to the end user/owner (Florida Department of Transportation).

1.09 QUALITY ASSURANCE

Manufacturer's Qualifications

1. A minimum of 20 years' experience in the design, manufacture and testing of solid-state UPS systems shall be required.
2. The quality system for the engineering and manufacturing facility shall be certified to conform to Quality System Standard ISO 9001 for the design and manufacture of power protection systems for computers and other sensitive electronics.

Factory Testing

1. Before shipment, the manufacturer shall fully and completely test the UPS unit to ensure compliance with the specification.
2. The UPS unit shall be tested at the system-specified capacity. Testing shall be done using load banks at part-load and the full kW rating of the unit.
3. Operational discharge and recharge tests to ensure guaranteed rated performance.
4. System operations such as startup, shutdown and transfers shall be demonstrated.

5. A certified copy of test results shall be available for each system as indicated on the order.

Installer's Qualifications:

1. Firm with at least 10 years of successful installation experience on projects utilizing UPS equipment similar to the size and complexity required for this project. Installer shall be a licensed electrician with experience installing at least three UPS systems of 200 KVA or larger. Installers shall be approved and certified to install the supplied manufacturers equipment.

PART 2 - PRODUCT

2.01 FABRICATION

A. Materials

1. All materials of the UPS shall be new, of current manufacture, high grade and shall not have been in prior service except as required during factory testing. All active electronic devices shall be solid-state. All power semiconductors shall be sealed. Control logic and fuses shall be physically isolated from power train components to ensure operator safety and protection from heat. All electronic components shall be accessible from the front without removing sub-assemblies for service access.

B. UPS Internal Wiring

1. Wiring practices, materials and coding shall be in accordance with the requirements of the National Electrical Code, OSHA and applicable local codes and standards. All bolted connections of busbars, lugs and cables shall be in accordance with requirements of the National Electric Code and other applicable standards. All electrical power connections shall be torqued to the required value and marked with a visual indicator.

C. Field Wiring

1. All field wiring power connections shall be to tin-plated copper busbars for connection integrity. Busbars shall have adequate space to allow two-hole long-barrel compression type lugs forming a permanent connection between field wiring and field-installed lugs.
2. Provisions shall be made in the cabinets to permit installation of input, output and external control cabling using raceway or conduit. Provision shall be made for top and bottom access to input, output, bypass and DC connections. In conformance with the NEC, connection cabinets shall provide for adequate wire bend radius.

D. Construction and Mounting

1. The UPS shall be in NEMA Type 1 enclosures, designed for floor mounting. The UPS shall be structurally adequate and have provisions for hoisting, jacking and forklift handling. Maximum cabinet height shall be 78.inches.

2. The UPS shall be NEMA Type 1-compliant, with front doors open to enable safe change of air filters without the need for shutdown.

E. Cooling

1. Adequate ventilation shall be provided to ensure that all components are operated well within temperature ratings.
2. Temperature sensors shall be provided to monitor the UPS's internal temperature. Upon detection of temperatures in excess of the manufacturer's recommendations, the sensors shall cause audible alarms to be sounded and visual alarms to be displayed on the UPS control panel. An internal, factory-mounted sensor for room ambient temperature shall be provided to give an alarm if the temperature of the inlet air to the UPS is above specified limits. Air filters shall be located at the point of air inlet and shall be changeable. No service clearance or ventilation shall be required in the rear of the system.

2.02 EQUIPMENT

UPS System

The UPS system shall consist of an IGBT power factor-corrected rectifier, DC-DC converter and three-phase, transformer-free inverter, bypass static transfer switch, bypass synchronizing circuitry, protective devices and accessories as specified. The specified system shall also include a battery disconnect breaker and battery system.

A. Surge Protection

1. The UPS shall have built-in protection against: surges, sags and overcurrent from the AC source. The protection shall meet the requirements of ANSI C62.41 B3 including:
 - a. 6kV, 100kHz ring wave, line-to-line, line-to-neutral, line-to-ground and neutral-to-ground
 - b. 6kV, combined wave, line-to-line, line-to-neutral, line-to-ground and neutral-to-ground

B. Output Protection

1. The UPS shall be protected against sudden changes in output load and short circuits at the output terminals. The UPS shall have built-in protection against permanent damage to itself and the connected load for all predictable types of malfunctions. Fast-acting, current-limiting devices shall be used to protect against cascading failure of solid-state devices. Internal UPS malfunctions shall cause the module to trip off-line with minimum damage to the module and provide maximum information to maintenance personnel regarding the reason for tripping off-line. The load shall be automatically transferred to the bypass line uninterrupted for an internal UPS malfunction. The status of protective devices shall be indicated on a graphic display screen on the front of the unit.

2.03 COMPONENTS

- A. Rectifier: The term *rectifier* shall denote the solid-state equipment and controls necessary to convert alternating current to regulated direct current to supply the inverter and charge the battery. The DC output of the rectifier shall meet the input requirements of the inverter without the battery being connected.

1. Input Current Harmonic Distortion
 - a. The rectifier shall actively control and reduce input current distortion over the full operating range of the UPS without the need for an additional passive input filter. Input current THD shall be less than 3% at rated load and nominal voltage in double-conversion mode.
 2. Input Current Walk-In
 - a. The rectifier/charger shall provide a feature that limits, during the transfer from battery mode to on-line mode, the total initial power requirement at the input terminals to 0% of rated load and gradually increases power to 100% of full rating over the 2.5 to 90-second (adjustable) time interval with full rated rectifier power.
 3. Dynamic Current Input Limit Reduction
 - a. The rectifier, in conjunction with the other UPS controls and circuitry, shall adjust the current demanded for battery charging as a function of UPS wattage load and input voltage level.
- B. DC-DC Converter: The term *DC-DC converter* shall denote the equipment and controls to regulate the output of the rectifier to the levels appropriate for charging the battery and to boost the battery voltage to the level required to operate the inverter. The DC-DC converter shall be solid-state, capable of providing rated output power, and for increased performance shall be a pulse width-modulated design and shall utilize insulated gate bipolar transistors (IGBTs). The DC-DC converter shall control charging of the battery. The AC ripple voltage of the charger DC shall not exceed 1% RMS of the float voltage.
1. Battery Recharge
 - a. In addition to supplying power for the load, the rectifier/charger shall be capable of supplying a minimum of 5% of the module full load power rating for recharging the battery. The battery recharge rate capability shall be sufficient to replace 95% of the battery discharge power within ten (10) times the discharge time while running at 95% of full load at nominal voltage, provided that the battery can accept recharge at that rate. After the battery is recharged, the rectifier/charger shall maintain the battery at full charge until the next emergency operation.
 2. Battery Equalize Charge
 - a. A manually initiated equalize charge feature shall be provided to apply an equalize voltage to the battery. The duration of equalize charge time shall be adjustable from 0 to 200 hours. A method shall be available to deactivate this feature for valve regulated battery systems.
 3. Thermal Runaway Protection and Battery Charger Control
 - a. The UPS shall provide temperature compensated charging. This function requires that the UPS be equipped with temperature sensors in each cabinet and an interface scheme provided by the UPS manufacturer. The UPS shall adjust the battery charging voltage based on the battery temperature reported from external battery temperature sensors. Temperature sensors shall be monitored for faulty measurements and shall be ignored if a fault is detected to prevent overcharging or undercharging the battery. When multiple sensors are used, the voltage shall be based on the average temperature measured. Excessive difference in the temperature measurements shall be reported and the charging voltage adjusted to protect the batteries from excessive

current. In addition, the UPS shall be programmable so that a battery overtemperature condition can be detected in any single battery cabinet and a three-stage response shall be initiated:

- aa. When the temperature in the cabinet reaches 100.4°F (38°C), temperature compensation shall be stopped and an alarm generated.
 - bb. When the temperature in the cabinet reaches 109.4°F (43°C), the charger will shut off completely and the circuit breaker for any individual overtemperature battery cabinet or string may be opened, isolating that cabinet or string only and retaining reduced battery protection for the UPS. This condition shall be displayed on the UPS HMI screen and in the event log.
 - cc. Once the breaker on the affected cabinet or string has been tripped, the UPS shall resume normal charging with the remaining battery cabinets or strings.
- b. The system shall meet the requirements of the IFC 2012 for preventing thermal runaway battery protection for the UPS. This condition will be displayed on the UPS HMI screen, and in the event log.
 - c. Battery charging may also be stopped by an external signal that may be activated by a contact closure to indicate “on generator” operation or other condition (including battery overtemperature, presence of excessive hydrogen, or failure of the room ventilator fan) under which battery charging is undesirable or inadvisable.

4. Overvoltage Protection

- a. There shall be DC overvoltage protection so that if the DC voltage rises to the pre-set limit, the UPS shall shut down automatically and initiate an uninterrupted load transfer to bypass, or shall disconnect the battery via the DC breaker(s) in the battery string.

5. Battery Load Testing

- a. The UPS shall be capable of performing battery load testing under operator supervision. To accomplish this, the rectifier shall reduce charging voltage to force the batteries to carry the load for a short time. If the curve of battery voltage drop indicates diminished battery capacity, the UPS shall display an alarm message. If the voltage drop indicates battery failure, the UPS shall terminate the test immediately and annunciate the appropriate alarms.

C. Inverter: The term *inverter* shall denote the equipment and controls to convert direct current from the rectifier or battery via the DC-DC converter to precise alternating current to power the load. The inverter shall be solid-state, capable of providing rated output power and, for increased performance, the inverter shall be a pulse-width-modulated design and shall utilize insulated gate bipolar transistors (IGBTs). To further enhance reliable performance and efficiency, the inverter shall not require an inverter output series static switch/isolator for the purposes of overload or fault isolation or transfers to bypass.

1. Overload Capability

- a. The inverter shall be able to sustain an overload across its output terminals while supplying full rated voltage for up to 150% for 60 seconds. The inverter shall be capable of at least 200% current for short-circuit conditions including phase-to-phase, phase-to-ground and three-phase faults. After the fault is removed, the UPS shall return to normal operation without damage. If the short circuit is sustained, the load shall

be transferred to the bypass source and the inverter shall disconnect automatically from the critical load bus.

2. Output Frequency

- a. The inverter shall track the bypass continuously, providing the bypass source maintains a frequency of 60Hz \pm 1% (0.6 Hz). The inverter shall change its frequency (slew rate) at less than 1Hz per second to maintain synchronous operation with the bypass. This shall allow make-before-break manual or automatic transfers. If the bypass fails to maintain proper frequency, the inverter shall revert to an internal oscillator, which shall be temperature compensated and shall hold the inverter output frequency to 0.1% from the rated frequency for steady-state and transient conditions. Drift shall not exceed 0.1% during any 24-hour period. Total frequency deviation, including short time fluctuations and drift, shall not exceed 0.1% from the rated frequency.

3. Phase-to-Phase Balance

- a. The inverter shall provide a phase-to-phase voltage displacement of no worse than \pm 3% with a 100% unbalanced load.

4. Battery Protection

- a. The inverter shall be provided with monitoring and control circuits to protect the battery system from damage due to excessive discharge. Inverter shutdown shall be initiated when the battery voltage has reached the end of discharge voltage. The battery end-of-discharge voltage shall be calculated and automatically adjusted for partial load conditions to allow extended operation without damaging the battery. Automatic shutdown based on discharge time shall not be acceptable.

D. Inverter Bypass Operation: For times when maintenance is required or when the inverter cannot maintain voltage to the load due to sustained overload or malfunction, a bypass circuit shall be provided to isolate the inverter output from the load and provide a path for power directly from an alternate AC (bypass) source. The UPS control system shall constantly monitor the availability of the inverter bypass circuit to perform a transfer. The bypass circuit shall consist of a continuous duty bypass static switch and an overcurrent protection device to isolate the static bypass switch from the bypass source. The bypass static switch shall denote the solid-state device incorporating SCRs (silicon-controlled rectifiers) that can automatically and instantaneously connect the alternate AC source to the load.

1. Static Bypass Switch Rating

- a. The static bypass switch shall be rated for continuous duty operation at full rated load for highest reliability without the use of mechanical devices as used with a momentary rated device.

2. Manual Load Transfers

- a. A manual load transfer between the inverter output and the alternate AC source shall be initiated from the control panel. Manually initiated transfers shall be make-before-break, utilizing the inverter and the bypass static switch.

3. Automatic Load Transfers

- a. An automatic load transfer between the inverter output and the alternate AC source shall be initiated if an overload condition is sustained for a

period in excess of the inverter output capability or due to a malfunction that would affect the output voltage. Transfers caused by overloads shall initiate an automatic retransfer of the load to the inverter only after the load has returned to a level within the rating of the inverter source and the alarm has been acknowledged.

4. Momentary Overloads

- a. In the event of a load current inrush or branch load circuit fault in excess of the inverter rating, the bypass static switch shall connect the alternate AC source to the load for at least 600 milliseconds, allowing up to 1000% of the normal rated output current to flow. Output voltage shall be sustained to the extent the alternate AC source capacity permits. If the overload condition is removed before the end of the 600-millisecond period, the bypass static switch shall turn Off and the load shall remain on inverter power. If the overload remains, then a transfer to the alternate AC source is to be completed.

5. Backfeed Protection

- a. As required by UL1778 and CSA, the static transfer switch shall not backfeed UPS power to the bypass distribution system while the UPS is operating on battery during a bypass power outage. The purpose of this requirement is to prevent the risk of electrical shock on the distribution system when the normal source of power is disconnected or has failed. If a shorted SCR is detected, the static transfer switch shall be isolated by an internal automatic circuit breaker and an alarm message shall be annunciated at the UPS control panel. The load shall remain on conditioned and protected power after detection of a shorted SCR and isolation of the bypass static switch.

6. Active Eco-Mode

- a. When selected, this mode of operation shall transfer the load to the bypass source and maintain it there as long as the bypass source frequency, slew rate and voltage are within the adjusted operating parameters. While in this mode, the inverter shall remain operating to monitor the bypass line to ensure a fast, in-phase transfer of the load to the UPS inverter. Should the bypass source go outside the adjusted limits, the bypass static switch shall turn Off, isolating the load from the bypass while the inverter assumes the full critical load. The load shall be transferred from the bypass source to the inverter while maintaining the output voltage within the ITIC and CBEMA curves.
- b. It shall be possible to control (Activate/ Deactivate) Eco-Mode from the touchscreen HMI, a programmed input contact or both.
- c. The UPS control shall have the capability to suspend Eco-Mode operation when certain conditions exist. A log of the times Eco Mode has been suspended shall be generated and be accessible to the user.

E. Display and Controls

1. UPS Control Panel

- a. The UPS shall be provided with a microprocessor-based control panel for operator interface (may also be referred to as *User Interface*, or *UI*) to configure and monitor the UPS. The control panel shall be located on the front of the unit where it can be operated without opening the hinged front door. A backlit, menu-driven, full-graphics, color touch screen

liquid crystal display shall be used to enter setpoints for the battery test (duration and end voltage), display system information, metering information, a one-line diagram of the UPS and battery, active events, event history, startup instructions and transfer and shutdown screens.

- b. No mechanical push buttons shall be used.
- c. Access to the control and configuration functions shall be protected by a four-digit passcode. After the passcode is keyed in, the user shall be prompted for a confirmation. The passcode shall not be required to access informational screens.

2. Logic

- a. UPS system logic and control programming shall be resident in a microprocessor-based control system with nonvolatile flash memory. Rectifier, inverter and system control logic shall utilize high-speed digital signal processors (DSPs). CANbus shall be used to communicate between the logic and the User Interface as well as the options. Switches, contacts and relays shall be used only to signal the logic system as to the status of mechanical devices or to signal user control inputs. Customer external signals shall be isolated from the UPS logic by relays or optical isolation.

3. Metered Values

- a. A microprocessor shall control the display and memory functions of the monitoring system. All three phases of three-phase parameters shall be displayed simultaneously. All voltage and current parameters shall be monitored using true RMS measurements for accuracy to $\pm 1\%$ of voltage, $\pm 3\%$ AC current. The following parameters shall be displayed:
 - aa. Input voltage, line-to-line
 - bb. Input current per phase
 - cc. Input frequency
 - dd. Input apparent power (kVA)
 - ee. Battery voltage
 - ff. Battery charging/discharging current
 - gg. Output voltage, line-to-line
 - hh. Output frequency
 - ii. Bypass input voltage, line-to-line
 - jj. Bypass input frequency
 - kk. Load current
 - ll. Load real power (kW), total and percentage
 - mm. Load apparent power (kVA), total and percentage
 - nn. Load percentage of capacity
 - oo. Battery temperature, each battery string
 - pp. Battery state of charge

4. Power Flow Indications

- a. A power flow diagram shall graphically depict whether the load is being supplied from the inverter, bypass or battery and shall provide, on the same screen, the status of the following components:
 - aa. AC Input Circuit Breaker (optional)
 - bb. Battery Circuit Breaker, each breaker connection of complete battery complement, complete disconnection and partial connection (one or more, but not all breakers open.)
 - cc. Backfeed Breaker
 - dd. Maintenance Bypass Status

5. Main Display Screen

- a. The main display screen of the UPS shall be the default screen and shall provide the following information:
 - aa. Operating in Eco-Mode
 - bb. System Status
 - cc. Warning Indicator
 - dd. Fault Indicator
 - ee. Bypass Input Voltage
 - ff. Bypass Input Frequency
 - gg. Input Voltage Line to Line
 - hh. Input Frequency
 - ii. Output Voltage, Line to Line
 - jj. Output Current, Per Phase
 - kk. Output Frequency
 - ll. DC Source Voltage
 - mm. DC Source Current

6. Touchscreen Control Buttons

- a. Buttons shall be provided to start and stop the inverter. A pop-up message requesting confirmation shall be displayed whenever a command is initiated that would change the status of the UPS.
- b. Other buttons shall be provided to reset faults and silence the alarm buzzer.

7. Event Log

- a. This menu item shall display the list of events that have occurred recently while the UPS was in operation. The Event Log shall store up to 200 events, with the oldest events being overwritten first if the capacity is reached.

8. Measures Menu

- a. A “measures menu” shall provide access to the full set of measurements for each functional block (rectifier, bypass, DC-DC converter, batteries, inverter and load).

9. Battery Status Indicator

- a. A battery status indicator shall display DC alarm conditions, temperature, battery state of charge, the present battery voltage, total discharge time, status of last battery test and battery time remaining during discharge. A graphical representation of the battery voltage during the discharge shall be displayed. The graphical representation shall remain in the monitoring system memory until the next discharge occurs and shall be available for review of the battery performance.
- b. The UPS shall provide the operator with controls to perform the following functions:
 - aa. Configure and manage manual battery test.
 - bb. Modify test duration and minimum voltage
 - cc. Start battery test
 - dd. Monitor test status and progression
 - ee. Stop battery test
 - ff. Battery test status

10. Alarms

- a. The control panel shall report the system-level alarms listed below. An audible alarm shall be activated when any of the following alarms occurs. All alarms shall be displayed in text form.

Placement into service or test mode	Inverter Off warning
Maintenance Bypass switch closed	Inverter Off pending command
Fan life exceeded	Current limit
Synchronization system fault	kW protection
DIC Power-up	Inverter Off for shutdown command
System shutdown (DIC generated)	Bypass switch open
ID card missing	Bypass line power failure
Calibration started	Bypass wrong phase rotation
Input air high temper	Bypass disabled for DC voltage low
Input air temp. out of range	Bypass overtemperature warnin
SBS output switch open	Low battery time remaining
SBS Bypass switch closed	Battery end of discharge
Do not insert battery switch	High battery temperature
Line power switch open	Battery temp. out of range
SBS output switch close	Temperature probe not responding
Inverter overtemperature warning	Battery autonomy test
DC undervoltage	High battery temperature
Overload warning	Battery temperature out of range

11. Controls

- a. System-level control functions shall be:
 - aa. Start Inverter (and transfer to inverter)
 - bb. Stop Inverter (after transferring to bypass)
 - cc. Startup Screen
 - dd. Battery Test Setpoint Adjustment
 - ee. Configure Manual Battery Test
 - ff. Initiate Manual Battery Test
 - gg. Reset (Fault Cleared)
 - hh. System Settings (Time, Date, Language, LCD Brightness, Passcode)
 - ii. Audio Silence Command
 - jj. Alarm Reset Command

12. Manual Procedures

- a. Load Transfers
 - aa. Two touch-screen buttons (START INVERTER, STOP INVERTER) shall provide the means for the user to transfer the load to Bypass and back on UPS.

F. Self-Diagnostics

1. Event Log File

- a. The control system shall maintain a log of the event conditions that have occurred during system operation. Each log shall contain the event name, event time/date stamp and a set/clear indicator.

G. Remote Monitoring Capability

1. Remote Service Delivery

- a. The UPS manufacturer shall provide remote monitoring capability with a user-supplied internet connection for remote diagnostic and monitoring of the UPS system to provide early warning of UPS and single module alarm conditions and out-of-tolerance conditions. This shall allow effective proactive maintenance and fast incident response. First year operation remote monitoring service shall be included.
2. Communication Cards
- aa. The UPS shall be equipped with one bay for an optional communication card.
 - aaa. Optional SNMP Web card, providing SNMP, Telnet and Web-management capability, shall be available.
 - bbb. Optional Dual Protocol card with choice of any two of the following protocols can be selected
 - aaaa. SNMP
 - bbbb. Modbus (over IP or RS-485)
 - cccc. BACnet
 - ccc. Optional Card for connection to off-site monitoring system.
3. Output Alarm Contacts
- aa. Dry contact outputs shall be provided for:
 - aaa. Summary Alarm
 - bbb. Bypass Active
 - ccc. Low Battery
 - ddd. Operating on generator
 - eee. AC Input Failure, and
 - fff. Two selectable.
4. Customer Input Contacts
- a. The UPS shall have four discrete input contacts available for the input and display of customer-provided alarm points or to initiate a pre-assigned UPS operation. Each input can be signaled by an isolated external normally open contact.
 - b. When an assembly is selected as a pre-assigned UPS operation, the following actions shall be initiated:
 - aa. On Generator—Provides selectable choices to enable or disable battery charging, and enable or disable Eco-Mode operation while on generator.
 - bb. Transfer to Bypass—Manual command to transfer from inverter operation to static bypass operation.
 - cc. Fast Power Off—Emergency Module Off (EPO) command to stop UPS operation.
 - dd. Start Battery Test—Manually initiate an automated battery test operation.
 - ee. Stop Battery Test—Manually stop an automated battery test operation.
 - ff. Acknowledge Fault—Acknowledge a UPS alarm condition and present faults will be reset.
 - gg. Bypass/Inverter Off—Emergency Power Off (EPO) command to stop UPS operation.
 - hh. External Maintenance Bypass Breaker (MBB) status (open or closed)

H. Battery Disconnect Breaker

- 1. The UPS shall have a properly rated circuit breaker (600VDC) to isolate it from the base module. This breaker shall be in a separate NEMA-1 enclosure or in a matching battery cabinet. When open, there shall be no battery voltage in the

UPS enclosure. The UPS shall be automatically disconnected from the battery by opening the breaker when the battery reaches the minimum discharge voltage level or when signaled by other control functions.

I. Battery Plant

The battery plant shall comply with the specifications of:
Matching battery power pack

1. Matching Battery Power Pack (VRLA Battery)

- a. The battery power pack shall consist of sealed, valve-regulated batteries and a properly rated circuit breaker (500VDC nominal, 600VDC maximum) for isolating the battery pack from the UPS. The battery cells and disconnect breaker shall be installed and housed in a NEMA-1 cabinet, matching the UPS style and design.
- b. The battery system shall be sized to support a 300kW load for 60 minutes. The battery system shall provide 100% initial capacity upon delivery.
- c. The battery shall be lead-calcium, sealed, valve-regulated type with a 3-year full warranty and a 7-year pro rata warranty under full float operation. The battery design shall utilize absorbent glass mat (AGM) technology to immobilize the electrolyte.
- d. Each cell shall be clearly identified as to cell type, voltage and capacity as well as manufacturing control group for future quality assurance traceability. All cells in the battery shall be tested to verify 100% system capacity. The equipment shall be designed and manufactured under a quality assurance program that is controlled and documented by written policies, procedures or instructions and that shall be carried out throughout the performance of the work. The quality assurance program shall conform to the requirements of ANSI N45.2, MIL I-45208A and MIL-Q-9858.

J. Optional Accessories

1. AC Input Circuit Breaker

- a. The rectifier shall have as an option an internal AC input circuit breaker. The circuit breaker shall be of the frame size and trip rating to supply full rated load and recharge the battery at the same time. The circuit breaker shall have an undervoltage release to open automatically if the control voltage is lost.

2. Remote Alarm Panel

- a. The remote alarm panel shall have LED alarm lights. An audible alarm shall sound upon any alarm condition. The surface-mounted NEMA 1 enclosed panel shall indicate:
 - aa. Load on UPS
 - bb. Load on Bypass
 - cc. Battery Discharging
 - dd. Low Battery Warning
 - ee. Overload
 - ff. Audible Alarm with Reset

2. Load Bus Sync Controller

- a. The Load Bus Sync Controller shall enable two independent single-module UPS units to stay in sync when operating on battery or unsynchronized input sources. The LBS Controller shall determine the master and slave relationship between UPS units. An LBS Controller shall be installed within each single-module UPS.
4. Dual Protocol Web Card
- a. A Web card shall be provided to deliver SNMP, SMS Text Messaging, Telnet and Web-based management capability for enhanced communication as well as a choice of any two of the following protocols:
 - aa. SNMP
 - bb. Modbus over IP or RS-485
 - cc. BACnet

PART 3 - EXECUTION

3.01 FIELD QUALITY CONTROL

The following commissioning, inspections and test procedures shall be performed by factory-trained field service personnel during the UPS startup.

A. Visual Inspection

1. Inspect equipment for signs of damage.
 2. Verify installation per drawings supplied with installation manuals or submittal package.
 3. Inspect cabinets for foreign objects.
 4. Verify that neutral and ground conductors are properly sized and configured per requirements as noted in drawings supplied with installation manuals or submittal package.
 5. Inspect electrolyte level in cells (flooded cells only).
 6. Inspect all cell cases.
 7. Inspect each cell for proper polarity.
 8. Verify that all printed circuit boards are configured properly.

B. Mechanical Inspection

1. Check all control wiring connections for tightness.
 2. Check all power wiring connections for tightness.
 3. Check all terminal screws, nuts and/or spade lugs for tightness.

C. Electrical Inspection

1. Check all fuses for continuity.
2. Confirm input and bypass voltage and phase rotation are correct.
3. Verify control transformer connections are correct for voltages being used.
 4. Ensure connection and voltage of the battery string(s).

3.02 UNIT STARTUP

- A. Energize control power.
- B. Perform control/logic checks and adjust to meet specification.

- C. Verify DC float and equalize voltage levels.
- D. Verify DC voltage clamp and overvoltage shutdown levels.
- E. Verify battery discharge, low battery warning and low battery shutdown levels.
- F. Verify fuse monitor alarms and system shutdown.
- G. Verify inverter voltages and regulation circuits.
- H. Verify inverter/bypass sync circuits and set overlap time.
- I. Perform manual transfers and returns.
- J. Simulate utility outage at no load.
- K. Verify proper recharge.
- L. Perform a complete commissioning process and functional, operational testing together with the generators, transfer switches and paralleling switchgear. Make all required adjustments for a satisfactorily functioning system. Provide up to 5 days of on-site technician assistance and attendance for commissioning, testing and start-up.**

3.03 MANUFACTURER'S FIELD SERVICE

A. Service Personnel

1. The UPS manufacturer shall directly employ a nationwide service organization, consisting of factory-trained field service personnel dedicated to the startup and maintenance of UPS and power equipment.
2. The manufacturer shall provide a national dispatch center to coordinate field service personnel schedules. One toll-free number shall reach a qualified support person 24 hours a day, 7 days a week and 365 days a year. If emergency service is required, on-site response time shall be 4 hours or less within 150 miles of the building.
3. Two local customer engineers shall be assigned to the site with a regional office as a backup. Escalation procedures shall be in place to notify Technical Support if a site is not functioning within 24 hours.

B. Automated Site Monitoring

1. The UPS manufacturer shall provide as an option an automated site monitoring service. This service shall be staffed by a qualified support person 24 hours a day, 7 days a week and 365 days a year. At the detection of an alarm within the UPS, the controls shall initiate communication with the monitoring service. The monitoring service shall be capable of interpreting the communicated alarms to allow dispatch of a service engineer.

C. Replacement Parts Stocking

1. Parts shall be available through an extensive network to ensure round-the-clock parts availability throughout the country.

2. Spare parts shall be stocked by local field service personnel with backup available from national parts centers and the manufacturing location. A Customer Support Parts Coordinator shall be on call 24 hours a day, 7 days a week, 365 days a year for immediate parts availability.

D. Maintenance Contracts

1. A complete offering of preventive and full-service maintenance contracts for both the UPS system and battery system shall be available.

END OF SECTION 26 33 53

SECTION 26 36 00
AUTOMATIC TRANSFER SWITCHES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and other related specification sections, apply to work of this section.
- B. Division 26 Basic Electrical Materials and Methods section apply to work specified in this section.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00.
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) requirements.

1.03 SCOPE

- A. Furnish and install automatic transfer switches (ATS) with number of poles, amperage, voltage, withstand and close-on ratings as shown on the plans. Each automatic transfer shall consist of an inherently double throw power transfer switch mechanism and a microprocessor controller to provide automatic operation. All transfer switches and controllers shall be the products of the same manufacturer of an entire ATS line from 30-4000 Amperes.

1.04 CODES AND STANDARDS

The automatic transfer switches and controls shall conform to the requirements of:

- A. UL 1008 - Standard for Transfer Switch Equipment
- B. IEC 947-6-1 Low-voltage Switchgear and Controlgear; Multifunction equipment; Automatic Transfer Switching Equipment
- C. NFPA 70, NFPA 99, NFPA 110
- D. IEEE Standard 446
- E. NEMA Standard ICS10-1993 (formerly ICS2-447) - AC Automatic Transfer Switches
- F. UL 508 Industrial Control Equipment

1.05 DRAWINGS AND MANUALS

- A. The ATS manufacturer shall provide the necessary interconnection diagrams for connecting the ATS's engine generator, and all other equipment related to the emergency generator system.

- B. Six (6) sets of instruction manuals and record drawings shall be furnished for the ATS's and their accessories.

1.06 SUBMITTALS:

- A. Submittal shall include specification sheets showing all standard and optional accessories to be supplied, schematic wiring diagrams, dimension drawings, and interconnection diagrams identifying by terminal number each required interconnection between the generator sets, the transfer switch, and other remote devices if included elsewhere in these specifications

1.07 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with all of the contract documents, the following manufacturers offering products that meet the requirements of these specifications may be considered. ATS shall be compatible with the supplied associated generators.
 - 1. ASCO – Vertiv (or with ASCO transfer mechanism)
 - 2. Russellelectric

PART 2 - PRODUCTS

2.01 MECHANICALLY HELD TRANSFER SWITCH

- A. The transfer switch shall be electrically operated and mechanically held. The electrical operator shall be a momentarily energized, single-solenoid mechanism. Main operators which include overcurrent disconnect devices, linear motors or gears shall not be acceptable. The switch shall be mechanically interlocked to ensure only two possible positions, normal or emergency.
- B. All transfer switch sizes shall use only one type of main operator for ease of maintenance and commonality of parts.
- C. The switch shall be positively locked and unaffected by momentary outages, so that contact pressure is maintained at a constant value and contact temperature rise is minimized for maximum reliability and operating life.
- D. All main contacts shall be silver composition. Switches rated 600 amperes and above shall have segmented, blow-on construction for high withstand and close-on capability and be protected by separate arcing contacts.
- E. Inspection of all contacts shall be possible from the front of the switch without disassembly of operating linkages and without disconnection of power conductors. Switches rated 600 amps and higher shall have front removable and replaceable contacts. All stationary and moveable contacts shall be replaceable without removing power conductors and/or bus bars.
- F. Designs utilizing components of molded-case circuit breakers, contactors, or parts thereof, which are not intended for continuous duty, repetitive switching or transfer between two active power sources are not acceptable.

- G. **Provide four pole transfer switches** as shown on the drawing. Switches shall be compatible with the GFI protection on the normal utility branch and the GFI indication on the emergency branch.

2.02 MICROPROCESSOR CONTROLLER

- A. The controller's sensing and logic shall be provided by a single built-in microprocessor for maximum reliability, minimum maintenance, and the ability to communicate via Modbus RTU and an optional serial communication module.
- B. A single controller shall provide twelve selectable nominal voltages for maximum application flexibility and minimal spare part requirements. Voltage sensing shall be true RMS type and shall be accurate to $\pm 1\%$ of nominal voltage. Frequency sensing shall be accurate to $\pm 0.2\%$.
- C. The controller shall be connected to the transfer switch by an interconnecting wiring harness. The harness shall include a keyed disconnect plug to enable the controller to be disconnected from the transfer switch for routine maintenance.
- D. All customer connections shall be wired to a common terminal block
- E. The controller shall meet or exceed the requirements for Electromagnetic Compatibility

2.03 ENCLOSURE

- A. The ATS shall be furnished in a NEMA type I enclosure unless otherwise shown on the plans.

2.04 BYPASS-ISOLATION SWITCH

- A. A two-way bypass-isolation switch shall provide manual bypass of the load to either source and permit isolation of the automatic transfer switch from all source and load power conductors. All main contacts shall be manually driven.
- B. Power interconnections shall be silver-plated copper bus bar. The only field installed power connections shall be at the service and load terminals of the bypass-isolation switch. All control interwiring shall be provided with disconnect plugs.
- C. Separate bypass and isolation handles shall be utilized to provide clear distinction between the functions. Handles shall be permanently affixed and operable without opening the enclosure door. Designs requiring insertion of loose operating handles or opening of the enclosure door to operate are not acceptable.
- D. Bypass to the load-carrying source shall be accomplished with no interruption of power to the load (make before break contacts). Designs which disconnect the load when bypassing are not acceptable. The bypass handle shall have three operating modes: "Bypass to Normal," "Automatic," and "Bypass to Emergency." The operating speed of the bypass contacts shall be the same as the associated transfer switch and shall be independent of the speed at which the manual handle is operated. In the "Automatic" mode, the bypass contacts shall be out of the power circuit so that they will not be subjected to fault currents to which the system may be subjected.
- E. The isolation handle shall provide at least three operating modes: "Closed," "Test," and "Open." The "Test" mode shall permit testing of the entire emergency power system,

including the automatic transfer switches with no interruption of power to the load. The "Open" mode shall completely isolate the automatic transfer switch from all source and load power conductors. When in the "Open" mode, it shall be possible to completely withdraw the automatic transfer switch for inspection or maintenance to conform to code requirements without removal of power conductors or the use of any tools.

- F. When the isolation switch is in the "Test" or "Open" mode, the bypass switch shall function as a manual transfer switch.
- G. Designs requiring operation of key interlocks for bypass isolation or ATSS, which cannot be completely withdrawn when isolated are not acceptable.
- H. Provide dry contacts for Bypass Position & ATS in Auto/Isolate/Test

2.05 SERVICE ENTRANCE RATED

- A. Not required.

2.06 SURGE PROTECTION DEVICES

- A. Provide an internal, integral, factory supplied and installed power (208Y/120 volt, 3 phase, neutral, and ground) surge suppression device.
- B. Provide surge suppression devices on all external communications cabling circuits. Surge devices shall be installed inside the ATS.

PART 3 - OPERATION

3.01 CONTROLLER DISPLAY AND KEYPAD

- A. A four line, 20 character LCD display and keypad shall be an integral part of the controller for viewing all available data and setting desired operational parameters.
- B. All instructions and controller settings shall be easily accessible, readable and accomplished without the use of codes, calculations, or instruction manuals.

3.02 VOLTAGE, FREQUENCY AND PHASE ROTATION SENSING

- A. Voltage and frequency on both the normal and emergency sources (as noted below) shall be continuously monitored, with the following pickup, dropout, and trip setting capabilities (values shown as % of nominal unless otherwise specified):

Parameter	Sources	Dropout/Trip	Pickup/Reset
Undervoltage	N&E,3φ	70 to 98%	85 to 100%
Overvoltage	N&E,3φ	102 to 115%	2% below trip
Underfrequency	N&E	85 to 98%	90 to 100%
Overfrequency	N&E	102 to 110%	2% below trip

Voltage unbalance N&E 5 to 20% 1% below dropout

- B. Repetitive accuracy of all settings shall be within $\pm 0.5\%$ over an operating temperature range of -20°C to 60°C .
- C. Voltage and frequency settings shall be field adjustable in 1% increments either locally with the display and keypad or remotely via serial communications port access.
- D. The controller shall be capable (when activated by the keypad or through the serial port) of sensing the phase rotation of both the normal and emergency sources. The source shall be considered unacceptable if the phase rotation is not the preferred rotation selected (ABC or CBA).
- E. Source status screens shall be provided for both normal & emergency to provide digital readout of voltage on all 3 phases, frequency, and phase rotation.

3.03 TIME DELAYS

- A. An adjustable time delay of 0 to 6 seconds shall be provided to override momentary normal source outages and delay all transfer and engine starting signals. Capability shall be provided to extend this time delay to 60 minutes by providing an external 24 VDC power supply.
- B. A time delay shall be provided on transfer to emergency, adjustable from 0 to 60 minutes, for controlled timing of transfer of loads to emergency.
- C. Two time delay modes (which are independently adjustable) shall be provided on re-transfer to normal. One time delay shall be for actual normal power failures and the other for the test mode function. The time delays shall be adjustable from 0 to 60 minutes. Time delay shall be automatically bypassed if the emergency source fails and the normal source is acceptable.
- D. A time delay shall be provided on shut down of engine generator for cool down, adjustable from 0 to 60 minutes.
- E. A time delay activated output signal shall also be provided to drive an external relay(s) for selective load disconnect control.
- F. All time delays shall be adjustable in 1-second increments, except the extended parallel time, which shall be adjustable in .01 second increments.
- G. All time delays shall be adjustable by using the LCD display and keypad or with a remote device connected to the serial communications port.

3.04 ADDITIONAL FEATURES

- A. A three position momentary-type test switch shall be provided for the test / automatic / reset modes. The test position will simulate a normal source failure. The reset position shall bypass the time delays on either transfer to emergency or retransfer to normal.
- B. A set of DPDT gold-flashed contacts rated 10 amps, 32 VDC shall be provided for a low-voltage engine start signal. The start signal shall prevent dry cranking of the engine by requiring the generator set to reach proper output, and run for the duration of the cool

down setting, regardless of whether the normal source restores before the load is transferred.

- C. Auxiliary contacts, rated 10 amps, 250 VAC shall be provided consisting of one contact, closed when the ATS is connected to the normal source and one contact closed, when the ATS is connected to the emergency source. In addition provide contacts for source availability of both normal and emergency.
- D. LED indicating lights (industrial grade, type 12) shall be provided; one to indicate when the ATS is connected to the normal source (green) and one to indicate when the ATS is connected to the emergency source (red).
- E. LED indicating lights (industrial grade, type 12) shall be provided and energized by controller outputs. The lights shall provide true source availability of the normal and emergency sources, as determined by the voltage sensing trip and reset settings for each source.
- F. Provide the ability to select “commit/no commit to transfer” to determine whether the load should be transferred to the emergency generator if the normal source restores before the generator is ready to accept the load.
- G. Terminals shall be provided for a remote contact which opens to signal the ATS to transfer to emergency and for remote contacts which open to inhibit transfer to emergency and/or retransfer to normal. Both of these inhibit signals can be activated through the keypad or serial port.
- H. An in-phase monitor shall be provided in the controller. The monitor shall control transfer so that motor load inrush currents (or motor back emf) when transferring to or from the utility/normal power source do not exceed normal starting currents, and shall not require external control of power sources. The in-phase monitor shall be specifically designed for and be the product of the ATS manufacturer.
- I. The controller shall be capable of accepting a normally open contact that will allow the transfer switch to function in a non-automatic mode using an external control device.
- J. Engine Exerciser - The controller shall be provided with an internal engine exerciser. The engine exerciser shall allow the user to program up to seven different exercise routines. At the end of the specified duration the switch shall transfer the load back to normal and run the generator for the specified cool down period. A 10-year life battery that supplies power to the real time clock in the event of a power loss will maintain all time and date information.
- K. System Status - The controller LCD display shall include a “System Status” screen which shall be readily accessible from any point in the menu by depressing the “ESC” key a maximum of two times. This screen shall display a clear description of the active operating sequence and switch position. Controllers that require multiple screens to determine system status or display “coded” system status messages, which must be explained by references in the operator’s manual, are not permissible.
- L. Self Diagnostics - The controller shall contain a diagnostic screen for the purpose of detecting system errors. This screen shall provide information on the status input signals to the controller which may be preventing load transfer commands from being completed.

- M. Communications Interface – The controller shall be capable of interfacing, through an optional serial communication module over Modbus.
- N. Data Logging – The controller shall have the ability to log data and to maintain the last 99 events, even in the event of total power loss. The following events shall be time and date stamped and maintained in a non-volatile memory:
 - 1. Event Logging
 - a. Data and time and reason for transfer normal to emergency.
 - b. Data and time and reason for transfer emergency to normal.
 - c. Data and time and reason for engine start.
 - d. Data and time engine stopped.
 - e. Data and time emergency source available.
 - f. Data and time emergency source not available.
 - 2. Statistical Data
 - a. Total number of transfers.
 - b. Total number of transfers due to source failure.
 - c. Total number of days controller is energized.
 - d. Total number of hours both normal and emergency sources available.
- O. Communications Module – An interface shall be installed in the ATS controller to enable Modbus communications. This module shall allow for the seamless integration of existing or new communication transfer devices.
- P. Ethernet Communication Card – Provide Ethernet Communication Card to allow for ATS monitoring of switch information including, time delays, switch position, source availability. Communication shall be connected to the SCADA network via RJ-45 Ethernet.
- Q. Provide all required communications to connect to the associated generators. ATS's shall be 100% compatible with the generators supplied.

PART 4 - ADDITIONAL REQUIREMENTS

4.01 WITHSTAND AND CLOSING RATINGS

- A. The ATS shall be rated to close on and withstand the available RMS symmetrical short circuit current at the ATS terminals with the type of overcurrent protection shown on the plans.
- B. The ATS shall be UL listed in accordance with UL 1008 7th Edition and shall include short time based ratings

4.02 TESTS AND CERTIFICATION

- A. The complete ATS shall be factory tested to ensure proper operation of the individual components and correct overall sequence of operation and to ensure that the operating transfer time, voltage, frequency and time delay settings are in compliance with the specification requirements.

- B. The ATS manufacturer shall be certified to ISO 9001 International Quality Standard and the manufacturer shall have third party certification verifying quality assurance in design/development, production, installation and servicing in accordance with ISO 9001.
- C. Commissioning. The ATS's shall be commissioned with the UPS and generators in place and operational.

4.03 SERVICE REPRESENTATION

- A. The ATS manufacturer shall maintain a national service organization of company-employed personnel located throughout the contiguous United States. Factory service technicians must be on call 24 hours a day, 365 days a year. In addition, the manufacturer shall have a service technician located within a 75-mile radius of the jobsite. Third party service centers do not met this requirement.
- B. The manufacturer shall maintain records of each switch, by serial number, for a minimum of 20 years.
- C. Provide a minimum of three days (72 hours) of start-up services as required to commission, test and set-up the system, including all coordination with the generators and UPS.

4.04 WARRANTY

- A. The ATS shall be provided with the following warranty.
 - 1. Two (2) Years Parts & Labor
 - 2. Includes parts, labor, and associated travel/lodging expenses if required.
 - 3. Five (5) Years Parts
 - 4. Ten (10) Years Main Contacts
 - 5. Optional warranties shall be available to extend Parts & Labor coverage to 5 or 10 years.
 - 6. All warrantied shall be passed through to the end user/Owner (Florida Department of Transportation).

5.0 POWER MANAGER

- A. Furnish load side ATS data monitors as shown to monitor all functions specified below.
- B. The Power Manager shall be accurate to 1% measured, 2% computed values and display resolution to .1%. Voltage and current for all phases shall be sampled simultaneously to assure high accuracy in conditions of low power factor or large waveform distortions (harmonics).
- C. Each Power Manager shall be capable of interfacing with an optional communications module to permit information to be sent to central location for display, analysis, and logging.

- D. The Power Manager shall be applied in 3-phase, three wire circuits. All CT's shall be mounted on the load side.
- E. All setup parameters required by the Power Manager shall be stored in non-volatile memory and retained in the event of a control power interruption.
- F. The following metered readings shall be communicated by the Power Manager, via serial communication, when equipped with optional serial communications module:
 - 1. Current, per phase RMS and neutral (if applicable)
 - 2. Current Unbalance %
 - 3. Voltage, phase-to-phase and phase-to-neutral
 - 4. Voltage Unbalance %
 - 5. Real power (KW), per phase and 3-phase total
 - 6. Apparent power (KVA), per phase and 3-phase total
 - 7. Reactive power (KVAR), per phase and 3-phase total
 - 8. Power factor, 3-phase total & per phase
 - 9. Frequency
 - 10. Accumulated Energy, (MWH, MVAH, and MVARH)
 - 11. Provide (8) solid state status inputs.
 - 12. Provide four (4) relay output contacts
- G. The Power Manager shall be equipped with a continuous duty, long-life, 4 line x 20 character LCD backlit display to provide local access to the following metered quantities
- H. Power Manager shall be provided with a Modbus output for interface with building Scada or BAS system.

END OF SECTION 26 36 00

SECTION 26 41 13
LIGHTNING PROTECTION SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions sections, apply to work of this section.
- B. This section is a Division-26 Electrical Methods and Materials Section applies to work specified in this section.
- C. Refer to Grounding and Bonding of Electrical Systems – Section 26 05 26.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00.
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) requirements.

1.03 SCOPE

- A. Scope of Work: Provide labor and materials for the installation of a complete building lightning protection system with a UL Master Label.
- B. Types of lightning protection system material and components specified in this section include the following:
 - 1. Air terminals.
 - 2. Bonding plates.
 - 3. Conductors.
 - 4. Connectors.
 - 5. Grounding rods.
 - 6. Rod clamps.
 - 7. Splicers.
 - 8. Wire.

1.04 QUALITY ASSURANCE

- A. Manufacturers: Firms regularly engaged in manufacture of lightning protection system components, of types, sizes, and ratings required, and who are Class I manufacturer-members of Lightning Protection Institute, whose products have been in satisfactory use in similar service for not less than three (3) years.
- B. Installer's Qualifications: Firm with at least 3 years of successful installation experience with projects utilizing lightning protection systems similar to that required for this project, and who are Class III, installer-members of Lightning Protection Institute.
- C. NEC Compliance: Comply with NEC requirements pertaining to lightning protection, grounding, grounding electrodes, and down conductor clearances.

- D. NFPA Compliance: Comply with requirements of NFPA No. 780 - 2011, "Lightning Protection Code", as applicable to lightning protection systems for building projects.
- E. UL Compliance: Comply with Master Label provisions of UL 96A, "Installation Requirements for Lightning Protection Components". Provide components which are UL 96 listed and labeled.
- F. LPI Compliance: Comply with requirements of Lightning Protection Institute (LPI) Standards 175, 176, and 177, pertaining to lightning system material, components, installation and testing procedures.
- G. UL Certification: Provide Owner with UL Master Label for overall system which is suitable for fastening to building for display purposes. Comply with UL 96A, "Master Labeled Lightning Protection Systems".
- H. OSHA Compliance: The lightning protection system shall comply with all current OSHA requirements, including the use of blunt, roof mounted air terminals.
- I. General: Provide lightning protection system material and components, of types, sizes, ratings, for Class of service indicated, which comply with manufacturer's standard materials, design, and construction in accordance with published product information, and as required for complete installation. Where type components or materials are not otherwise indicated, comply with NFPA 780 and LPI standards.

1.05 SUBMITTALS

- A. Product Data: Submit manufacturer's data on lightning protection systems and associated components.
- B. Shop Drawings: Submit layout drawings of lightning protection system equipment and components including, but not limited to, conductor routing, connections, and grounding.
- C. UL Certification: Provide Owner with UL Master Label for overall system which is suitable for fastening to building for display purposes. Comply with UL 96A, "Master Labeled Lightning Protection Systems".

PART2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with all of the contract documents, manufacturers offering products that meet the requirements of these specifications may be considered.

2.02 LIGHTNING PROTECTION SYSTEM COMPONENTS

- A. General: Provide lightning protection system material and components, of types, sizes, ratings, for Class I service utilizing copper materials, which comply with manufacturer's standard materials, design, and construction in accordance with published product information, and as required for complete installation. Where type components or materials are not otherwise indicated, comply with NFPA 780 and UL standards.
- B. In addition to conformance to NFPA-780 and UL 96, the component material requirements are as follows:

1. Conductors: Electrical grade stranded copper.
 2. Air terminals: Solid copper, not less than 3/8-inch diameter, with sharp nickel-plated points, 18 inches minimum.
 3. Ground rods: Copperclad steel, not less than 1/2-inch diameter by 8 feet long.
 4. Ground plates: Solid copper, not less than 1/16-inch thick.
 5. Tubing: Stiff copper or brass.
- C. Anchors and fasteners: Bolt types which are most suitable for the specific anchor and fastener installations.
- D. Ground Loop (Ring): Install ground-level, potential equalization conductor and extend around the perimeter of the building.
1. Bury ground ring not less than 24 inches from building foundation.
 2. Bond ground terminals to the ground loop.
 3. Bond grounded building systems to the ground loop conductor within 12 feet of grade level.
 4. Connections shall be made in ground test wells. See grounding specifications.
- E. Bond all metal structures, roof drains, mechanical equipment and any other metallic equipment required to be bonded to the system per NFPA-780.
- F. Provide lightning protection on the generator enclosures.
- G. Use lightning protection materials that are compatible with the metal to be bonded or fastened.

PART 3 - EXECUTION

3.01 INSTALLATION OF LIGHTNING PROTECTION SYSTEMS

- A. Install lightning protection system to protect the associated structure, in accordance with equipment manufacturer's written instructions, and in compliance with applicable requirements of NEC and NFPA 780 to ensure that lightning protection systems comply with requirements.
- B. Coordinate with other work, including electrical wiring and roofing work, as necessary to interface installation of lightning protection system with other work.
- C. Install conductors with direct paths from air terminals to ground connections avoiding sharp bends and narrow loops.
- D. All conductors shall be concealed from direct view from the ground. Down conductors shall be concealed.

3.02 GROUNDING AND BONDING

- A. Provide equipment grounding and bonding connections, sufficiently tight to assure permanent and effective grounds and bonds, for lightning protection connection to all air terminals, devices, equipment and structural components as necessary. All grounding and bonding shall be in compliance with the National Electrical Code - 2020, Section 250 - Grounding and NFPA-780.

3.03 TESTING

- A. Upon completion of installation of lightning protection system, test resistance-to-ground (earthing connection) with resistance tester. Where tests indicate resistance-to-ground is over 5 ohms, take appropriate action to reduce resistance to 5 ohms or less, by driving additional, properly spaced, ground rods, and treating soil in proximity to ground rods with common salt, copper sulfate or magnesium sulfate. Then retest to demonstrate compliance.

END OF SECTION 26 41 13

SECTION 26 43 13
SURGE PROTECTION DEVICES FOR LOW VOLTAGE ELECTRICAL POWER CIRCUITS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other general Specification Sections, apply to this Section.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00.
 - 1. Refer to "PART 2 – PRODUCTS" for all Buy America Build America Act (BABA) requirements.

1.03 SUMMARY

- A. This Section includes transient voltage surge suppressors for low-voltage (600Volts and below) power equipment
- B. Related Sections include the following:
 - 1. "Wiring Devices" transient voltage surge suppressors.
 - 2. "Panelboards"
 - 3. "Switchboards"

1.04 SUBMITTALS

- A. Request for submittals must be in writing and attached with independent documentation of the following items.
- C. Drawings: Electrical and mechanical drawings shall be provided by the manufacturer which show unit dimensions, weights, mounting provisions, connection notes, wire size and wiring diagram.
 - 1. SPD's with dimensions that exceed the available space to mount the device within the required maximum lead lengths will be rejected and not accepted. Verify maximum lead lengths can be met prior to bid.
- D. Equipment Manual: The manufacturer shall furnish an installation manual with installation notes, start-up and operating instructions for the specified system. Installation instructions shall clearly state whether the system requires an external overcurrent device to maintain the system's UL 1449 listing. SPD requiring external overcurrent devices are not acceptable.
- E. Verification that all SPD are UL 1449 5th Edition (VZCA) listed and rated with a 20kA (In) nominal discharge rating for compliance to UL96A Lightning Protection Master Label and NFPA 780. Also provide UL 1449 5th Edition VPR showing the following maximum VPR (clamping voltage) as follows:

1. 120Vsystem 600V (L-N)
2. 277Vsystem 1200V (L-N)

- F. SPD manufacturer shall provide UL 5th Edition documentation as part of submittal.
- G. Manufacturer's Warranty Statement, showing a 10 year replacement warranty for modules or unit are damaged by transient voltages

1.05 STANDARDS

- A. Underwriters Laboratories 1449 - (UL 1449 5th edition safety standard for surge protection devices)
- B. NEC article 285. National Electrical Code 2020 SPD shall be labeled with a minimum 200kAIC rating.
- C. NFPA 780 Standard for the installation of lightning protection systems
- D. UL96A - Lightning Protection System Master Label
- E. IEEE (Institute of Electrical and Electronic Engineering Inc.) C62.41.1 and C62.41.2, IEEE C62.45, IEEE C62.33 & C62.35
- F. All manufacturers must comply with above listed standards and any additions current revisions of industry standards. All products that do not comply with current industry standards will not be accepted.

1.06 QUALITY ASSURANCE

- A. Source Limitations: Obtain suppression devices and accessories through one source from a single manufacturer.

1.07 PROJECT CONDITIONS

- A. Placing into Service: Do not energize or connect service entrance equipment, panel boards, control terminals, or data terminals to their sources until the surge protective devices are installed and connected.
- B. Service Conditions: Rate surge protective devices for continuous operation under the following conditions, unless otherwise indicated:
 1. Maximum Continuous Operating Voltage (MCOV): Not less than 115 percent
 2. Operating Temperature: 30 to 120 deg F (0 to 50 deg C).
 3. Humidity: 0 to 85 percent, non-condensing.
 4. Altitude: Less than 20,000 feet (6000 m) above sea level.

1.08 COORDINATION

- A. Coordinate location of field-mounted surge suppressors to allow adequate clearances for maintenance.
- B. Coordinate surge protective devices with Division 26 Section "Panelboards" and "Switchboards".

1.09 WARRANTY

- A. General Warranty: Special warranties specified in this Article shall not deprive Owner of other rights owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.
- B. Manufacturer shall provide a product warranty for a period of not less than ten (10) years from date of installation. Warranty shall cover unlimited replacement of TVSS modules during the warranty period. Those firms responding to this specification shall provide proof that they have been regularly engaged in the design, manufacturing and testing of TVSS for not less than ten (10) years. Warranty shall be made out in the name of the State of Florida Department of Transportation.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with all of the contract documents, manufacturers offering products that meet the requirements of these specifications may be considered.

2.02 SERVICE ENTRANCE SUPPRESSORS (SPD1)

<u>Panel Amperage</u>	<u>≥3,000Amps</u>	<u>2500-1600Amps</u>	<u>1200-400Amps</u>
Service Entrance	400kA/Modular	300kA/modular	200kA/modular

- A. Provide service entrance rated, UL Type 1 SPD's as shown and indicated on contract drawings.
- B. Minimum surge current ratings per phase shown above, three phase, wye systems per phase rating shall equal L-N and L-G modes added together. No other methods are acceptable for per phase surge current rating calculations.
- C. SPD's shall be a multi-stage parallel connected device.
- D. SPD's UL 1449 3rd Edition VPR (clamping voltage) shall be a maximum rating of:
 - 1. 120Vsystem 700V (L-N)
 - 2. 277Vsystem 1200V (L-N)
- E. SPD's shall mount external to the panel; internally mounted SPD's are not acceptable.
- F. SPD voltages shall be verified by location on drawings, one-line diagrams and equipment schedules.
- G. SPD shall be modular design with field replaceable modules per phase and per mode.**
- H. SPD shall have redundant status indicators on the front of the enclosure and shall monitor and indicate whether suppression capabilities have been compromised.
- I. SPD shall contain protective components that utilize multiple thermally protected metal oxide varistors (MOV) per mode.

- J. SPD's relying upon external and/or supplementary installed safety overcurrent protection do not meet the intent of this specification.
- K. SPD's that are limited to being connected to breaker whether or not an integral disconnect switch is supplied do not meet the intent of this specification.
- L. SPD's shall have an UL "In" rating (nominal discharge) of 20kA.
- M. SPD shall have dry contacts for remote monitoring capabilities.
- N. Service Entrance SPD's shall have audible alarms and surge counters.
- O. SPD's shall have a metal, NEMA 4 rated enclosure.
- P. SPD shall be designed and equipped with integral disconnecting means.
- Q. Protection modes: The SPD shall provide Line to Neutral (L-N) (Wye), Line to Ground (L-G) (Wye or Delta), Line to Line (L-L) (Delta) and Neutral to Ground (N-G) (Wye) protection.

2.03 DISTRIBUTION, BRANCH PANEL AND/OR AUXILIARY PANELS (SPD2)

<u>Panel Amperage</u>	<u>1200-800A</u>	<u>600A</u>	<u>400-100A</u>
Distribution	200kA	200kA	200kA
Branch Panels		100kA	100kA

- A. Provide UL Type 2 SPD's as shown and indicated on contract drawings.
- B. SPD's minimum surge current ratings per phase shown above, three phase, wye systems per phase rating shall equal L-N and L-G modes added together. No other methods are acceptable for per phase surge current rating calculations.
- C. SPD's shall be a multi-stage parallel connected device.
- D. SPD's shall mount external to the panel; internally mounted SPD's are not acceptable.
- E. SPD voltages shall be verified by location on drawings, one-line diagrams and equipment schedules.
- F. SPD shall be a compact, non-modular design
- G. SPD shall have per phase status indicators on the front of the enclosure and shall monitor and indicate whether suppression capabilities have been compromised.
- H. SPD shall contain protective components that utilize multiple thermally protected metal oxide varistors (MOV) per mode.
- I. SPD's relying upon external and/or supplementary installed safety overcurrent protection do not meet the intent of this specification.
- J. SPD's shall have an UL "In" rating (nominal discharge) of 20kA.
- K. SPD shall have dry contacts for remote monitoring capabilities.

- L. SPD's shall have a metal, NEMA 4 rated enclosure
- M. Protection modes: The SPD shall provide Line to Neutral (L-N) (Wye), Line to Ground (L-G) (Wye or Delta), Line to Line (L-L) (Delta) and Neutral to Ground (N-G) (Wye) protection.

PART 3 - EXECUTION

3.01 INSTALLATION OF SURGE PROTECTIVE DEVICES

- A. Review all installation information in manufacturer's installation manual prior to installing SPD's.
- B. Verify all voltages before connecting to avoid injury and damage to equipment.
- C. The SPD's shall be installed external to switchboard, distribution and panelboard.
- D. Internally mounted SPD's will not be accepted.
- E. The service entrance/switchboard/switchgear SPD's shall be installed with the shortest lead length possible and shall avoid any unnecessary or sharp bends. SPD's shall be connected to breakers with a 30 amp, 3 pole breaker for connection means.
- F. The distribution, panelboard and auxiliary SPD's shall be installed with the shortest lead length possible from the panel it is protecting and shall avoid any unnecessary or sharp bends. SPD's shall be connected to breakers with a 30 amp, 3 pole breaker for connection means.
- G. Ground resistance shall be 5 Ohms or less.
- H. Refer to manufacturer's installation manual for further installation details.

3.02 FIELD QUALITY CONTROL

A INSTALLATION

1. After installing surge protective devices, but before electrical circuitry has been energized, test for compliance with manufacturers' installation instruction requirements and recommendations.

B MANUFACTURERS FIELD SERVICE

1. Engage a factory authorized service representative to inspect equipment installation. Report results in writing
2. Verify that electrical wiring installation complies with manufacturer's installation requirements.

END OF SECTION 26 43 13

SECTION 26 51 00
INTERIOR BUILDING LUMINAIRES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.
- B. Division-26 Basic Electrical Materials and Methods section apply to work specified in this section.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00.
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) requirements.

1.03 DESCRIPTION OF WORK

- A. Extent of interior luminaire work is indicated by drawings and schedules.
- B. Types of interior luminaires in this section include the following:
 - 1. LED
- C. Applications of interior luminaires required for project including the following:
 - 1. General lighting
 - 2. Supplementary lighting
 - 3. Task lighting
 - 4. Emergency lighting

1.04 QUALITY ASSURANCE

- A. Manufacturers: Firms regularly engaged in manufacture of interior luminaires of types and ratings required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Installer: Qualified with at least 3 years of successful installation experience on projects with interior luminaire work similar to that required for project.
- C. NEC Compliance: Comply with NEC as applicable to installation and construction of interior building luminaires.
- D. NEMA Compliance: Comply with applicable requirements of NEMA Std Pub Nos. LE 1 and LE 2 pertaining to lighting equipment.

- E. ANSI/IES Compliance: Comply with ANSI 132.1 pertaining to interior luminaires.
- F. ANSI/UL Compliance: Comply with ANSI/UL standards pertaining to interior luminaires for hazardous locations.
- G. UL Compliance: Provide interior luminaires which have been UL-listed and labeled.

1.05 SUBMITTALS

- A. Product Data: Submit manufacturer's data on interior building luminaires, lamps and drivers. Catalog numbers on the luminaire schedule are intended to describe the general luminaire requirements. The luminaire description, catalog number and actual use and location of the luminaire shall be utilized as the full luminaire specification requirements. Provide required accessories and options as necessary to meet the full specification and drawing requirements.
 - 1. Submit complete catalog and technical data on lamps and drivers.
- B. Shop Drawings: Submit luminaire shop drawings in booklet form with separate sheet for each luminaire, assembled in luminaire "type" alphabetical order, with proposed luminaire and accessories clearly indicated on each sheet.
- C. Point-by-point foot-candle calculations shall be submitted for any or all areas when requested by the engineer.
- D. Luminaires will not be accepted without complete lamp and driver submittals. Luminaires will not be accepted without acceptable lamps and drivers.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Manufacturers/Catalog Numbers: Subject to compliance with requirements, provide luminaires manufactured by manufacturers as indicated on the luminaire schedule. Catalog numbers given on the luminaire schedule are intended to provide the general description of the required luminaire and its quality. Additional accessories, mounting hardware, options, etc., not specifically described by the catalog number but required for a properly operating and installed luminaire or as described by additional notation on the drawings or in the specifications, shall be provided.
 - 1. Substitutions will not be considered without a full submittal package, complete with point-by-point calculations. Any substitutions that are considered must be prior approved by written addendum.

2.02 INTERIOR LUMINAIRES

- A. General: Provide luminaires, of sizes, types, and ratings indicated; complete with, but not necessarily limited to, housings, lamps, lamp holders, reflectors, drivers, starters and wiring.
- B. LED: LED luminaires shall be rated/tested to LM-79 standards

Provide energy saving LED-lamp drivers, compatible with the LED lamps and luminaire; Type 1, Class P; sound-rated A, and with internal thermal protection. All LED lamp type

and associated driver for each individual type luminaire shall be of the same manufacturer and type. Drivers shall also meet the following requirements:

1. Operate LED lamps with no detectable flicker and provide for dimming where specified. Driver shall be compatible with the dimmers provided and installed. Provide written documentation of compatibility.
 2. Driver manufacturer shall have been producing LED drivers in the U.S. for more than three years with a low failure rate.
 3. Drivers shall be approved and listed by UL.
 4. Drivers shall comply with all applicable state and federal efficiency standards.
 5. Drivers shall comply with FCC and NEMA limits governing electromagnetic and radio frequency interference and shall not interfere with operation of other normal electrical equipment.
 6. Drivers shall meet all applicable ANSI and IEEE standards regarding harmonic distortion and surge protection, but in no case shall have total harmonic distortion exceeding 10%.
 7. Drivers shall not be affected by lamp failure and shall yield normal published expected lamp life.
 9. Drivers shall operate at an input frequency of 60 HZ and an input voltage of 108 to 132 volts.
 12. Driver assembly shall carry a minimum three year warranty, including labor allowance.
- C. Fusing: All LED drivers shall be fused or be provided with automatic electronic thermal overload protection. Drivers shall be capable of being disconnected at the luminaire for service and replacement.

2.03 LED LAMPS

- A. Lamps: Provide LED lamps that comply with LM-80 standards. **LED lamps shall be rated for a minimum of 50,000 hours life. Lamps shall be provided with a minimum 3 year warranty.**

2.04 ATTIC STOCK

- A. Provide 2 drivers for each luminaire/driver type, including remote drivers.

PART 3 - EXECUTION

3.01 INSTALLATION OF INTERIOR LUMINAIRES

- A. Install interior luminaires at locations and heights as indicated, in accordance with luminaire manufacturer's written instructions, applicable requirements of NEC, NECA's "Standard of Installation", NEMA standards, and with recognized industry practices to ensure that luminaires fulfill requirements.

- B. Coordinate with other electrical work as appropriate to properly interface installation of interior luminaires with other work.
- C. Fasten luminaires securely to building structural support; and ensure that pendant luminaires are plumb and level. Provide all required mounting hardware and steel channel to supplement structural support where necessary. Luminaires shall not be supported from ductwork, piping, conduits, ceiling grid or any other non-structural building member. Luminaires may be supported from the ceiling grid only if the grid is properly supported from the building structure at a minimum of two corners at every luminaire plus other supplemental support where deemed necessary. In addition, luminaires supported from a properly supported grid shall have grid hold-down clips installed. Hold-down clips shall be specifically manufactured for this purpose and shall be supplied with the luminaires.
- D. Coordinate luminaire installation with mechanical duct work, diffusers, return grilles, communication systems devices, etc., to avoid any interferences.
- E. Pendant mounted luminaires shall securely mounted with a luminaire factory supplied stem/cable mount. Provide supplemental structural steel (uni-strut, kindorf, etc.) to secure the lights to the building structure.
- F. Pendant mounted direct/indirect luminaires shall be supported directly to the building structure, or via supplemental structural steel (uni-strut, kindorf). Any and all exposed supplemental steel or pendants, boxes, raceway, etc., shall be painted to match the surrounding area, or painted the color as directed by the architect. Luminaires shall be straight and plumb, with no visible gaps in continuous runs.

3.02 ADJUST AND CLEAN

- A. Clean interior luminaires of dirt and debris upon completion of installation
- B. Protect installed luminaires from damage during remainder of construction period.

3.03 FIELD QUALITY CONTROL

- A. Upon completion of installation of interior luminaires, and after building circuitry has been energized, apply electrical energy to demonstrate capability and compliance with requirements. where possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with retesting.
- B. At the time of Substantial Completion, replace lamps in interior luminaires which are observed to be noticeably dimmed after Contractor's use and testing, as judged by Architect/Engineer.
- C. Refer to Division-1 sections for the replacement/restoration of lamps in interior luminaires, where used for temporary lighting prior to time of Substantial Completion.
- D. Any and all exposed mounting hardware and supplemental steel mounting hardware (uni-strut, kindorf, etc.) shall be painted to match the surrounding areas or painted the color as directed by the architect. Exposed mounting hardware shall be prior approved by the architect before installation.

3.04 GROUNDING

- A. Provide tight equipment grounding connections for each interior luminaire installation.

3.05 COMMISSIONING

- A. Commissioning of the project will be required in accordance with the Florida Energy Code. Refer to the commissioning specification, section 23 08 00 for more requirements, and other applicable specification sections. Provide all required materials, testing and labor to complete the commissioning procedures.

END OF SECTION 26 51 00

SECTION 26 56 00
EXTERIOR BUILDING LUMINAIRES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 00 Specification sections, apply to work of this section.
- B. Division 26 Basic Electrical Materials and Methods section apply to work specified in this section.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00.
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) requirements.

1.03 DESCRIPTION OF WORK

- A. Extent of exterior luminaire work is indicated by drawings and schedules.
- B. Types of exterior luminaires in this section include the following:
 - 1. LED
- C. Applications of exterior luminaires required for project including the following:
 - 1. Outdoor supplementary lighting

1.04 QUALITY ASSURANCE

- A. Manufacturers: Firms regularly engaged in manufacture of exterior luminaires of types and ratings required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Installer: Qualified with at least 3 years of successful installation experience on projects with exterior luminaire work similar to that required for project.
- C. NEC Compliance: Comply with NEC as applicable to installation and construction of exterior building luminaires.
- D. UL Compliance: Provide exterior luminaires which are UL-listed and labeled.
- E. CBM Labels: Provide ballasts which comply with Certified Ballast Manufacturers Association standards and carry the CBM label.

1.05 SUBMITTALS

- A. Physical description of luminaire, including materials, dimensions, effective projected area, and verification of indicated parameters. Full specification data sheets.
- B. Details of attaching luminaires and accessories.
- C. Details of installation and construction.
- D. Luminaire materials.
- E. Photometric data based on laboratory tests of each luminaire type, complete with indicated lamps, ballasts, and accessories.
 - 1. Submit complete point-by-point photometric calculations utilizing the LLF and LDD factors provided by the engineer.
 - 2. Testing Agency Certified Data: Photometric data shall be certified by a qualified independent testing agency.
 - 3. Manufacturer Certified Data: Photometric data shall be certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
 - 4. Submit all lamp and driver information complete
- F. LED drivers, including energy-efficiency data.
- G. Lamps, including life, output, CCT, CRI, lumens, and energy-efficiency data.
- H. Materials, dimensions, and finishes of poles.
- I. Means of attaching luminaires to supports, and indication that attachment is suitable for components involved.
- J. Anchor bolts for poles, if applicable.
- K. When applicable, submit manufactured poles and pole foundations. Provide complete lighting pole and pole base shop drawings for each pole type and location, where the location conditions differ. Provide pole and pole base wind load rating calculations signed and sealed by a Florida registered professional engineer.
 - 1. Provide geotechnical soil testing or other tests if necessary or required by the engineer of record for the poles and pole bases, where applicable.
- L. Wiring Diagrams: For control and switching wiring.
- M. Samples: The Engineer shall be provided with a sample of each fixture for review upon request. Each Sample shall include lamps and drivers. Lamps and drivers may be requested separately. The samples shall be retrieved by the contractor upon completion of review.

- N. Point-by-point foot-candle calculations shall be provided for all exterior lighting, including driveways, parking area, property line, and stairs.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Manufacturers/Catalog Numbers: Subject to compliance with requirements, provide fixtures manufactured by manufacturers as indicated on the fixture schedule. Catalog numbers given on the fixture schedule are intended to provide the general description of the required fixture and its quality. Additional accessories, mounting hardware, options, etc., not specifically described by the catalog number but required for a properly operating and installed fixture or as described by additional notation on the drawings or in the specifications, shall be provided.
 - 1. Point-by-point calculations will be required to be submitted. Engineer will provide the design criteria and maintenance factors.
 - 2. Substitutions will not be considered without a full submittal package, complete with point-by-point calculations. Any substitutions that are considered must be prior approved by written addendum.

2.02 EXTERIOR LUMINAIRES

- A. General: Provide luminaires, of sizes, types, and ratings indicated; complete with, but not necessarily limited to, housings, lamps, lamp holders, reflectors, drivers/ballasts, starters and wiring. The level of quality, general material, and manufacturing of the fixtures shall be as per the basis of design fixture, lamp and ballast and driver selection.
 - 1. LED luminaires shall be rated/tested to LM-79 standards.
- B. LED lamps shall be rated for a minimum 50,000 hours, or as indicated on the drawings, and shall be rated/tested/listed in accordance with LM-80 as a minimum. Provide lamps and drivers suitable for use in the outdoor environment.
- C. Poles: Site lighting poles shall be installed straight and plumb, and shall be as scheduled on the drawings. The pole and base shall be rated for the prevailing wind load as required by the Florida Building Code for the EPA of the luminaires and bracket arm, for the current version in affect at the time the project bids. Structural design for wind load ratings of the pole and base shall be performed by a Florida registered professional engineer and signed and sealed proof of compliance shall be submitted with the lighting shop drawings.
- D. Driver/Lamp Warranty: Provide a minimum five year lamp and ballast/driver (where applicable) guarantee. This warranty shall be provided as an assembly with the ballast and lamp manufacturer agreeing to provide the required warranty with the associated ballast or lamp.
- E. Fixture and Pole Warranty: Provide a minimum five year luminaire and light pole guarantee, including bollards. This warranty shall be provided as an assembly with the ballast and lamp, or separately from the driver & lamp.

PART 3 - EXECUTION

3.01 INSTALLATION OF EXTERIOR LUMINAIRES

- A. Install exterior luminaires at locations and heights as indicated, in accordance with fixture manufacturer's written instructions, applicable requirements of NEC, NECA's "Standard of Installation", NEMA standards, and with recognized industry practices to ensure that luminaires fulfill requirements.
- B. Coordinate with other electrical work as appropriate to properly interface installation of exterior luminaires with other work.
- C. Fasten fixtures securely to required structural supports; and check to ensure that solid pendant fixtures are plumb.
- D. All poles shall be straight and plumb.
- E. Complete all control connections, including connection to the HVAC controls for on/off controls. Test all controls, program all timing for on/off periods based upon the Owner's request, and verify proper operation.

3.02 ADJUST AND CLEAN

- A. Clean exterior luminaires of dirt and debris upon completion of installation.
- B. Protect installed fixtures from damage during remainder of construction period.

3.03 FIELD QUALITY CONTROL

- A. Upon completion of installation of exterior luminaires, and after building circuitry, apply electrical energy to luminaires to demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with retesting.
- B. At the time of Substantial Completion, replace lamps in exterior luminaires which are observed to be noticeably dimmed after Contractor's use and testing, as judged by Engineer.
- C. Refer to Division 00 sections for the replacement/restoration of lamps in exterior luminaires, where used for temporary lighting prior to time of Substantial Completion.

3.04 GROUNDING

- A. Provide tight equipment grounding connections for each exterior luminaire installation.

3.05 COMMISSIONING

- A. Commissioning of the project will be required in accordance with the Florida Energy Code. Refer to the commissioning specification, section 23 08 00 for more requirements, and other applicable specification sections. Provide all required materials, testing and labor to complete the commissioning procedures.

END OF SECTION 26 56 00

SECTION 26 56 13
LIGHTING POLES AND STANDARDS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other related Specification sections, apply to this section.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00.
 - 1. Refer to "PART 2 – PRODUCTS" for all Buy America Build America Act (BABA) requirements.

1.03 SUMMARY

- A. Section Includes:
 - 1. Poles and accessories for support of luminaires.

1.04 DEFINITIONS

- A. EPA: Equivalent projected area.
- B. Luminaire: Complete lighting fixture.
- C. Pole: Luminaire-supporting structure.
- D. Standard: See "Pole."

1.05 ACTION SUBMITTALS

- A. Product Data: For each pole, accessory, and luminaire-supporting and -lowering device, arranged as indicated.
 - 1. Include data on construction details, profiles, EPA, cable entrances, materials, dimensions, weight, rated design load, and ultimate strength of individual components.
 - 2. Include finishes for lighting poles and luminaire-supporting devices.
 - 3. Anchor bolts.
 - 4. Pole foundations.
- B. Shop Drawings:
 - 1. Include plans, elevations, sections, and mounting and attachment details.

2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Detail fabrication and assembly of poles and pole accessories.
4. Foundation construction details, including material descriptions, dimensions, anchor bolts, support devices, and calculations, signed and sealed by a professional engineer licensed in the state of installation.
5. Anchor bolt templates keyed to specific poles and certified by manufacturer.
6. Method and procedure of pole installation. Include manufacturer's written installations.
7. Provide signed and sealed pole and pole base structural drawings indicating compliance with the Florida Building Code, using the local soil conditions. Drawings shall be sealed by a Florida registered professional structural engineer.

1.06 INFORMATIONAL SUBMITTALS

- A. Pole and Support Component Certificates: Signed by manufacturers of poles, certifying that products are designed for indicated load requirements according to AASHTO LTS-6-M and that load imposed by luminaire and attachments has been included in design. The certification shall be based on design calculations signed and sealed by a Florida Registered professional structural engineer. Loads and design shall be based upon the wind speeds and wind ratings required by the Florida Building Code for the area of this project.
- B. Material Test Reports:
 1. For each foundation component, by a qualified testing agency.
- C. Sample Warranty: Manufacturer's standard warranty. Warranty shall be in the name of the Owner, not the Contractor.
- D. Soil test reports

1.07 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For poles to include in emergency, operation, and maintenance manuals.
 1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include pole inspection and repair procedures.

1.08 MAINTENANCE MATERIAL SUBMITTALS

- A. Pole repair materials.

1.09 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualified according to ASTM C 1093 for foundation testing.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Package aluminum poles for shipping according to ASTM B 660.
- B. Store poles on decay-resistant skids at least 12 inches above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.
- C. Retain factory-applied pole wrappings on metal poles until right before pole installation. Handle poles with web fabric straps.

1.11 WARRANTY

- A. Warranty: Manufacturer agrees to repair or replace components of poles that fail in materials or workmanship; that corrode; or that fade, stain, perforate, erode, or chalk due to effects of weather or solar radiation within a specified warranty period. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs from special warranty period.

- 1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design pole foundation and pole power system.
- B. Dead Load: Weight of luminaire and its horizontal and vertical supports, lowering devices, and supporting structure, applied according to AASHTO LTS-6-M.
- C. Live Load: Single load of 500 lbf distributed according to AASHTO LTS-6-M.
- D. Wind Load: Pressure of wind on pole and luminaire, calculated and applied according to AASHTO LTS-6-M.
 - 1. Basic wind speed for calculating wind load for poles shall be based upon the requirements of the Florida Building Code.
- E. Strength Analysis: For each pole, multiply the actual EPA of luminaires and brackets by a factor of 1.0 to obtain the EPA to be used in pole selection strength analysis.
- F. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts unless otherwise indicated.
- G. Poles and pole bases shall be in compliance with Florida Department of Transportation standards.

2.02 ALUMINUM POLES

- A. Poles: Seamless, extruded structural tube complying with ASTM B 221, Alloy 6063-T6, with access handhole in pole wall.
 - 1. Shape: Round, tapered.
 - 2. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.
- B. Mast Arms (as needed to attach luminaire): Aluminum Single-arm type, continuously welded to pole attachment plate. Material and finish same as plate.
- C. Brackets for Luminaires: Detachable, cantilever, without underbrace.
 - 1. Adaptor fitting welded to pole, allowing the bracket to be bolted to the pole-mounted adapter, then bolted together with stainless-steel bolts.
 - 2. Cross Section: Tapered oval, with straight tubular end section to accommodate luminaire. Match pole material and finish.
- D. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.
- E. Grounding and Bonding Lugs: Bolted 1/2-inch threaded lug, complying with requirements in Section 260526 "Grounding and Bonding for Electrical Systems," listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.
- F. Fasteners: Stainless steel, size and type as determined by manufacturer. Corrosion-resistant items compatible with support components.
 - 1. Materials: Compatible with poles and standards as well as to substrates to which poles and standards are fastened and shall not cause galvanic action at contact points.
 - 2. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication unless otherwise indicated.
- G. Handhole: Oval shaped, with minimum clear opening of 2-1/2 by 5 inches, with cover secured by stainless-steel captive screws.
- H. Aluminum Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" recommendations for applying and designating finishes.
 - 1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
 - 2. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20 requirements; and seal aluminum surfaces with clear, hard-coat wax.

2.03 POLE ACCESSORIES

- A. Where indicated on the drawings, provide a duplex receptacle on the pole. Ground-fault circuit interrupter type, 120 V ac, 20 A in a weatherproof "in-use" assembly. Comply with requirements in Section 262726 "Wiring Devices."
 - 1. Recessed 18 inches above finished grade.
 - a. NEMA 250, Type 4X, nonmetallic polycarbonate plastic or reinforced fiberglass, enclosure with cover; color to match pole.
 - b. Lockable hasp and latch complying with OSHA lockout and tag-out requirements.
- B. Base Covers: Manufacturers' standard metal units, finished same as pole, and arranged to cover pole's mounting bolts and nuts.

2.04 MOUNTING HARDWARE

- A. Anchor Bolts: Manufactured to ASTM F 1554, Grade 55, with a minimum yield strength of 55,000 psi (380,000 kPa).
- B. Nuts: ASTM A 563, Grade A, Heavy-Hex
- C. Washers: ASTM F 436, Type 1.

2.05 GENERAL FINISH REQUIREMENTS

- A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine poles, luminaire-mounting devices, lowering devices, and pole accessories before installation. Components that are scratched, dented, marred, wet, moisture damaged, or visibly damaged are considered defective.
- C. Examine roughing-in for foundation and conduit to verify actual locations of installation.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 POLE FOUNDATION

- A. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Structural steel complying with ASTM A 36/A 36M and hot-dip galvanized according to ASTM A 123/A 123 M; and with top-plate and mounting bolts to match pole-base flange and strength required to support pole, luminaire, and accessories. Concrete, reinforcement, and formwork are specified in Section 03 30 00 "Cast-in-Place Concrete."
- B. Pre-Cast Foundations: Factory fabricated, with structural steel complying with ASTM A 36/A 36M and hot-dip galvanized according to ASTM A 123/A 123M; and with top-plate and mounting bolts to match pole-base flange and strength required to support pole, luminaire, and accessories. Concrete, reinforcement, and formwork are specified in Section 03 30 00 "Cast-in-Place Concrete."
- C. Anchor Bolts: Install plumb using manufacturer-supplied template, uniformly spaced.

3.03 POLE INSTALLATION

- A. Alignment: Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on pole.
- B. Clearances: Maintain the following minimum horizontal distances of poles from surface and underground features unless otherwise indicated on drawing.
 - 1. Fire Hydrants and Water Piping: 60 inches.
 - 2. Utility Company Water, Gas, Electric, Communications, and Sewer Lines: 10 feet.
 - 3. Trees: 10 feet from tree trunk.
- C. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer. Concrete materials, installation, and finishing requirements are specified in Section 03 30 00 "Cast-in-Place Concrete."
- D. Foundation-Mounted Poles: Mount pole with leveling nuts and tighten top nuts to torque level according to pole manufacturer's written instructions.
 - 1. Use anchor bolts and nuts selected to resist forces defined for the application and approved by manufacturer.
 - 2. Grout void between pole base and foundation. Use non shrink or expanding concrete grout firmly packed to fill space.
 - 3. Install base covers unless otherwise indicated.
 - 4. Use a short piece of 1/2 -inch diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.

3.04 CORROSION PREVENTION

- A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum using insulating fittings or treatment.

- B. Steel Conduits: Comply with requirements in Section 26 05 33 "Raceways and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch thick, pipe-wrapping plastic tape applied with a 50-percent overlap.

3.05 GROUNDING

- A. Ground Metal Poles and Support Structures: Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."
 - 1. Install grounding electrode for each pole unless otherwise indicated.
 - 2. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.
- B. Ground Nonmetallic Poles and Support Structures: Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."
 - 1. Install grounding electrode for each pole.
 - 2. Install grounding conductor and conductor protector.
 - 3. Ground metallic components of pole accessories and foundation.

3.06 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.07 FIELD QUALITY CONTROL

- A. Perform the following inspections:
 - 1. Inspect poles for nicks, mars, dents, scratches, and other damage.
 - 2. System function tests.
 - 3. Inspect for pole level, plumb and straight.

END OF SECTION 26 56 13

SECTION 27 05 26
GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Grounding conductors.
 - 2. Grounding connectors.
 - 3. Grounding busbars.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00:
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) Requirements.

1.03 DEFINITIONS

- A. Retain terms that remain after this Section has been edited for a project.
- B. BCT: Bonding conductor for telecommunications.
- C. EMT: Electrical metallic tubing.
- D. TGB: Telecommunications grounding busbar.
- E. TMGB: Telecommunications main grounding busbar.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For communications equipment room signal reference grid. Include plans, elevations, sections, details, and attachments to other work.

PART 2 - PRODUCTS

2.01 SYSTEM COMPONENTS

- A. Comply with J-STD-607-A.

2.02 CONDUCTORS

- A. Comply with UL 486A-486B.

- B. Insulated Conductors: Stranded copper wire, green or green with yellow stripe insulation, insulated for 600 V, and complying with UL 83.
 - 1. Ground wire for custom-length equipment ground jumpers shall be No. 6 AWG, 19-strand, UL-listed, Type THHN/THWN-2 wire.
 - 2. Cable Equipment Rack Grounding Wire: No. 6 AWG.
- C. Cable Tray Grounding Jumper:
 - 1. Not smaller than No. 6 AWG and not longer than 12 inches. If jumper is a wire, it shall have a crimped grounding lug with two holes and long barrel for two (2) crimps. If jumper is a flexible braid, it shall have a one-hole ferrule. Attach with grounding screw or connector provided by cable tray manufacturer.
- D. Bare Copper Conductors:
 - 1. Solid Conductors: ASTM B 3.
 - 2. Stranded Conductors: ASTM B 8.
 - 3. Tinned Conductors: ASTM B 33.
 - 4. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
 - 5. Bonding Jumper: Tinned-copper tape, braided conductors terminated with two-hole copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

2.03 CONNECTORS

- A. Irreversible connectors listed for the purpose. Listed by an NRTL as complying with NFPA 70 for specific types, sizes, and combinations of conductors and other items connected. Comply with UL 486A-486B.
- B. Compression Wire Connectors: Crimp-and-compress connectors that bond to the conductor when the connector is compressed around the conductor. Comply with UL 467.
- C. Busbar Connectors: Cast silicon bronze, solderless compression or exothermic-type, mechanical connector; with a long barrel and two holes spaced on 5/8- or 1-inch centers for a two-bolt connection to the busbar.
- D. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.04 GROUNDING BUSBARS

- A. TMGB: Predrilled, wall-mounted, rectangular bars of hard-drawn solid copper, 1/4 by 4 inches in cross section, length as indicated on Drawings. The busbar shall be NRTL listed for use as TMGB and shall comply with J-STD-607-A.
 - 1. Predrilling shall be with holes for use with lugs specified in this Section.

2. Mounting Hardware: Stand-off brackets that provide a 2-inch clearance to access the rear of the busbar. Brackets and bolts shall be stainless steel.
 3. Stand-off insulators for mounting shall be Lexan or PVC. Comply with UL 891 for use in 600-V switchboards, impulse tested at 5000 V.
- B. Cabinet Grounding Busbars: Rectangular bars of hard-drawn solid copper, accepting conductors ranging from No. 14 to No. 2/0 AWG, NRTL listed as complying with UL 467, and complying with J-STD-607-A. Predrilling shall be with holes for use with lugs specified in this Section.
1. Cabinet-Mounted Busbar: Terminal block, with stainless-steel or copper-plated hardware for attachment to the cabinet.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine the ac grounding electrode system and equipment grounding for compliance with requirements for maximum ground-resistance level and other conditions affecting performance of grounding and bonding of the electrical system.
- B. Inspect the test results of the ac grounding system measured at the point of BCT connection.
- C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- D. Proceed with connection of the BCT only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Bonding shall include the ac utility power service entrance, the communications cable entrance, and the grounding electrode system. The bonding of these elements shall form a loop so that each element is connected to at least two others.
- B. Comply with NECA 1.
- C. Comply with J-STD-607-A.

3.03 APPLICATION

- A. Conductors: Install solid conductor for No. 8 AWG and smaller and stranded conductors for No. 6 AWG and larger unless otherwise indicated.
 1. The bonding conductors between the TGB and structural steel of steel-frame buildings shall not be smaller than No. 6 AWG.
 2. The bonding conductors between the TMGB and structural steel of steel-frame buildings shall not be smaller than No. 6 AWG.

- B. Underground Grounding Conductors: Install bare copper conductor, No. 2 AWG minimum.
- C. Conductor Terminations and Connections:
 - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
 - 2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
 - 3. Connections to Ground Rods at Test Wells: Bolted connectors.
 - 4. Connections to Structural Steel: Welded connectors.
- D. Conductor Support:
 - 1. Secure grounding and bonding conductors at intervals of not less than 36 inches.
- E. Grounding and Bonding Conductors:
 - 1. Install in the straightest and shortest route between the origination and termination point, and no longer than required. The bend radius shall not be smaller than eight times the diameter of the conductor. No one bend may exceed 90 degrees.
 - 2. Install without splices.
 - 3. Install grounding and bonding conductors in 3/4-inch PVC conduit until conduit enters a telecommunications room. The grounding and bonding conductor pathway shall be bonded to the conductor at both ends with a conductor that the same as the grounding and bonding conductor.

3.04 GROUNDING ELECTRODE SYSTEM

- A. The BCT between the TMGB and the ac service equipment ground shall not be smaller than No. 1/0 AWG.

3.05 GROUNDING BUSBARS

- A. Indicate locations of grounding busbars on Drawings. Install busbars horizontally, on insulated spacers 2 inches minimum from wall, 12 inches above finished floor unless otherwise indicated.
- B. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down; connect to horizontal bus.

3.06 CONNECTIONS

- A. Bond metallic equipment in a telecommunications equipment room to the grounding busbar in that room, using equipment grounding conductors not smaller than No. 6 AWG.
- B. Stacking of conductors under a single bolt is not permitted when connecting to busbars.

- C. Assemble the wire connector to the conductor, complying with manufacturer's written instructions and as follows:
 - 1. Use crimping tool and the die specific to the connector.
 - 2. Pre-twist the conductor.
 - 3. Apply an antioxidant compound to all bolted and compression connections.
- D. Primary Protector: Bond to the TMGB with insulated bonding conductor.
- E. Interconnections: Interconnect all TGBs with the TMGB with the telecommunications backbone conductor. If more than one TMGB is installed, interconnect TMGBs using the grounding equalizer conductor. The telecommunications backbone conductor and grounding equalizer conductor size shall not be less than 2 kcmils/linear foot of conductor length, up to a maximum size of No. 3/0 AWG unless otherwise indicated.
- F. Telecommunications Enclosures: Bond metallic components of enclosures to the telecommunications bonding and grounding system. Install vertically mounted rack grounding busbar unless the enclosure is manufactured with the busbar. Bond the equipment grounding busbar to the TGB via No. 6 AWG bonding conductors.
- G. Telecommunication Racks: Bond each rack to the TGB via No. 6 AWG bonding conductors.
- H. Electrical Power Panelboards: Where an electrical panelboard for telecommunications equipment is located in the same room or space, bond each TGB to the ground bar of the panelboard.
- I. Shielded Cable: Bond the shield of shielded cable to the TGB in communications rooms and spaces. Comply with TIA-568-C.1 and TIA-568-C.2 when grounding shielded balanced twisted-pair cables.
- J. Cabinet-Mounted Equipment: Bond powered equipment chassis to the cabinet or rack grounding bar. Power connection shall comply with NFPA 70; the equipment grounding conductor in the power cord of cord- and plug-connected equipment shall be considered as a supplement to bonding requirements in this section.

3.07 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

- A. Duct-Bank Grounding Conductor: Bury 12 inches above duct bank when indicated as part of duct-bank installation.
- B. Comply with IEEE C2 grounding requirements.
- C. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches extends above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches above

to 6 inches below concrete. Seal floor opening with waterproof, non-shrink grout.

- D. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect grounding conductors to cable armor and cable shields according to written instructions by manufacturer of splicing and termination kits.

END OF SECTION 27 05 26

SECTION 27 05 28
PATHWAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Metal conduits and fittings.
2. Nonmetallic conduits and fittings.
3. Optical-fiber-cable pathways and fittings.
4. Metal wireways and auxiliary gutters.
5. Boxes, enclosures, and cabinets.
6. Hooks

B. Related Requirements:

1. Section 26 05 43 "Underground Raceways for Electrical Systems" for exterior ductbanks, manholes, and underground utility construction.
2. Section 26 05 33 "Raceways and Boxes for Electrical Systems" for conduits, wireways, surface raceways, boxes, enclosures, cabinets, handholes, and faceplate adapters serving electrical systems.
3. Section 28 05 28 "Pathways for Electronic Safety and Security" for conduits, surface pathways, innerduct, boxes, and faceplate adapters serving electronic safety and security.

1.02 RELATED WORK

A. SUMMARY OF WORK: Section 01 11 00:

1. Refer to "PART 2 – PRODUCTS" for all Buy America Build America Act (BABA) Requirements.

1.03 DEFINITIONS

- A. GRC: Galvanized rigid conduit.
- B. IMC: Intermediate metal conduit.
- C. EMT: Electrical metallic tubing.

1.04 ACTION SUBMITTALS

- A. Product data: For floor boxes, hinged-cover enclosures, and cabinets.
- B. LEED Submittals:
 - 1. Product Data for Credit IEQ 4.1: For solvent cements and adhesive primers, documentation including printed statement of VOC content.
- C. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

1.05 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For professional engineer.

PART 2 - PRODUCTS

2.01 METAL CONDUITS AND FITTINGS

- A. General Requirements for Metal Conduits and Fittings:
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 2. Comply with TIA-569-D.
- B. GRC: Comply with ANSI C80.1 and UL 6.
- C. IMC: Comply with ANSI C80.6 and UL 1242.
- D. EMT: Comply with ANSI C80.3 and UL 797.
- E. COMMUNICATION RELATED CONDUIT SHALL BE IN 1 -INCH AND LARGER SIZED CONDUIT.
- F. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
 - 1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 1203 and NFPA 70.
 - 2. Fittings for EMT:
 - a. Material: Steel or die cast.
 - b. Type: Compression
 - 3. Expansion Fittings: PVC or steel to match conduit type, complying with UL-467, rated for environmental conditions where installed, and including flexible external bonding jumper.

2.02 NONMETALLIC CONDUITS AND FITTINGS

- A. General Requirements for Nonmetallic Conduits and Fittings:
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 2. Comply with TIA-569-D.
- B. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.
- C. Rigid HDPE: Comply with UL 651A.
- D. Fittings for RNC: Comply with NEMA TC 3; match to conduit and material.
- E. Solvents and adhesive primers shall have a VOC content of 510 and 550 g/L or less, respectively, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.03 OPTICAL-FIBER-CABLE PATHWAYS AND FITTINGS

- A. Description: Comply with UL 2024A; flexible-type pathway with a circular cross section, approved for general-use installation unless otherwise indicated.
 - 1. Quantity of cells: 3.
 - 2. Size: 4 inch.
 - 3. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 4. Comply with TIA-569-D
- B. METAL WIREWAYS AND AUXILIARY GUTTERS
- C. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1 unless otherwise indicated, and sized according to NFPA 70.
- D. General Requirements for Metal Wireways and Auxiliary Gutters:
 - 1. Comply with UL 870 and NEMA 250, Type 1 unless otherwise indicated, and sized according to NFPA 70.
 - 2. Comply with TIA-569-D.
- E. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
- F. Wireway Covers: Hinged type unless otherwise indicated.
- G. Finish: Manufacturer's standard enamel finish.

2.04 BOXES, ENCLOSURES, AND CABINETS

- A. General Requirements for Boxes, Enclosures, and Cabinets:
 - 1. Comply with TIA-569-D.
 - 2. Boxes, enclosures and cabinets installed in wet locations shall be listed for use in wet locations.
- B. Sheet-Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
- C. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.
- D. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
- E. Floor Boxes:
 - 1. See Section 26 05 33.
- F. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- G. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, galvanized, cast iron with gasketed cover.
- H. Device Box Dimensions: 4 11/16 inches by 2-1/8 inches deep.
- I. Gangable boxes are prohibited.
- J. Non-Metallic Outlet Device Boxes: Comply with NEMA OS 2 and UL 515C.
- K. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 with continuous-hinge cover with flush latch unless otherwise indicated.
 - 1. Metal Enclosures: Steel, finish inside and out with manufacturer's standard enamel.
 - 2. Interior Panels: Steel; all sides finished with manufacture's standard enamel.

2.05 HOOKS

- A. Description: Prefabricated sheet metal cable supports for telecommunications cable.
- B. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- C. Comply with TIA-569-D.
- D. Stainless steel.
- E. J Shape.

PART 3 - EXECUTION

3.01 PATHWAY APPLICATION

- A. Outdoors: Apply pathway products as specified below unless otherwise indicated:
 - 1. Exposed Conduit: GRC or IMC.
 - 2. Concealed Conduit, Aboveground: GRC or IMC.
 - 3. Underground Conduit: RNC, Type EPC-40-PVC, direct buried.
 - 4. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.
- B. Indoors: Apply pathway products as specified below unless otherwise indicated:
 - 1. Exposed, Not Subject to Physical Damage, above 8 feet AFF: EMT.
 - 2. Exposed, Subject Damage, Below 8 feet AFF, other than mechanical and electrical rooms: GRC or IMC.
 - 3. Concealed in Ceilings and Interior Walls and Partitions: EMT
 - 4. Damp or Wet Locations: GRC or IMC.
 - 5. Pathways for Optical-Fiber or Communications Cable in Spaces Used for Environmental Air: Plenum-type, communications-cable pathway. For ISP rated cable, and EMT for OSP rated cable.
 - 6. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel units in institutional and commercial kitchens and damp or wet locations.
- C. Minimum Pathway Size: 1-inch trade size for copper and aluminum cables, and 1 inch for optical-fiber cables.
- D. Pathway Fittings: Compatible with pathways and suitable for use and location.
 - 1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
 - 2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
 - 3. EMT: Use compression, steel or cast-metal fittings. Comply with NEMA FB 2.10.
- E. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.
- F. Install surface pathways only where indicated on Drawings.

- G. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F

3.02 INSTALLATION

- A. Comply with the following standards for installation requirements except where requirements on Drawings or in this Section are stricter:
 - 1. NECA 1.
 - 2. NECA 101/BICSI 568.
 - 3. TIA-569-D.
 - 4. NECA 102.
- B. Comply with NFPA 70 limitations for types of pathways allowed in specific occupancies and number of floors.
- C. Keep pathways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal pathway runs above water stream piping.
- D. Comply with requirements in Section 270529 "Hangers and Supports for Communications Systems" for hangers and supports.
- E. Complete pathway installation before starting conductor installation.
- F. Arrange stub-ups so curved portions of bends are not visible above finished slab.
- G. Install no more than the equivalent of two 90-degree bends in any pathway run. Support within 12 inches of changes in direction. Utilize long radius ells for all optical-fiber cables.
- H. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- I. Support conduit within 36 inches of enclosures to which attached.
- J. Pathways Embedded in Slabs:
 - 1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure pathways to reinforcement at maximum 10-foot (3-m) intervals.
 - 2. Arrange pathways to cross building expansion joints at right angles with expansion fittings. Comply with requirements for expansion joints specified in this article.
 - 3. Arrange pathways to keep a minimum of 2 inch of concrete cover in all directions.
 - 4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.
- K. Stub-ups to Above Recessed Ceilings:

1. Use EMT, IMC, or RMC for pathways.
 2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
- L. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of pathway and fittings before making up joints. Follow compound manufacturer's written instructions.
- M. Coat field-cut threads on PVC-coated pathway with a corrosion-preventing conductive compound prior to assembly.
- N. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install insulated bushings on conduits terminated with locknuts.
- O. Install pathways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus one additional quarter-turn.
- P. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure, to assure a continuous ground path.
- Q. Cut conduit perpendicular to the length. For conduits of 2-inch trade size and larger, use roll cutter or a guide to ensure cut is straight and perpendicular to the length.
- R. Install pull wires in empty pathways. Use polypropylene or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches of slack at each end of pull wire. Secure pull wire, so it cannot fall into conduit. Cap pathways designated as spare alongside pathways in use.
- S. Surface Pathways:
1. Install surface pathway for surface telecommunications outlet boxes only where indicated on Drawings.
 2. Install surface pathway with a minimum 2-inch radius control at bend points.
 3. Secure surface pathway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight pathway section. Support surface pathway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.
- T. Pathways for Optical-Fiber and Communications Cable: Install pathways, metal and nonmetallic, rigid and flexible, as follows:
1. 1-Inch trade Size and Larger: Install pathways in maximum lengths of 75 feet.
 2. Install with a maximum of two 90-degree bends or equivalent for each length of pathway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.

- U. Install pathway-sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed pathways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install pathway-sealing fittings according to NFPA 70.
- V. Install devices to seal pathway interiors at accessible locations. Locate seals, so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all pathways at the following points:
 - 1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 - 2. Where an underground service pathway enters a building or structure.
 - 3. Where otherwise required by NFPA 70.
- W. Comply with manufacturer's written instructions for solvent welding PVC conduit and fittings.
- X. Expansion-Joint Fittings:
 - 1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F (17 deg C), and that has straight-run length that exceeds 25 feet (7.6 m). Install in each run of aboveground RMC and EMT that is located where environmental temperature change may exceed 100 deg F (55 deg C), and that has straight-run length that exceeds 100 feet (30 m).
 - 2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
 - a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F (70 deg C) temperature change.
 - b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F (86 deg C) temperature change.
 - c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F (70 deg C) temperature change.
 - d. Attics: 135 deg F (75 deg C) temperature change.
 - 3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F (0.06 mm per meter of length of straight run per deg C) of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.00078 inch per foot of length of straight run per deg F (0.0115 mm per meter of length of straight run per deg C) of temperature change for metal conduits.
 - 4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.

5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

Y. Hooks:

1. Size to allow a minimum of 25 percent future capacity without exceeding design capacity limits.
2. Shall be supported by dedicated support wires. Do not use ceiling grid support wire or support rods.
3. Hook spacing shall allow no more than 6 inches (150 mm) of slack. The lowest point of the cables shall be no less than 6 inches (150 mm) adjacent to ceilings, mechanical ductwork and fittings, luminaires, power conduits, power and telecommunications outlets, and other electrical and communications equipment.
4. Space hooks no more than 5 feet (1.5 m) o.c.
5. Provide a hook at each change in direction.

Z. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.

AA. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surface to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.

BB. Horizontally separate boxes mounted on opposite sides of walls, so they are not in the same vertical channel.

CC. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

DD. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

EE. Set metal floor boxes level and flush with finished floor surface.

FF. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

3.03 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:

1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom for pipe of less than 6 inches (150 mm) in nominal diameter.

2. Install backfill.
3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches (300 mm) of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction.
4. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through floor unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.
5. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.
 - a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches (75 mm) of concrete around conduit for a minimum of 12 inches (300 mm) on each side of the coupling.
 - b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches (1500 mm) from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.
6. Install Orange colored, detectable (containing metallic tracing tape at 12-inches below surface where communication cabling is routed on the site.

3.04 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

- A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.
- B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch (12.5-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.
- C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch (25 mm) above finished grade.
- D. Install handholes with bottom below frost line, below grade.
- E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in enclosure.
- F. Field cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

3.05 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR COMMUNICATIONS PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 270544 "Sleeves and Sleeve Seals for Communications Pathways and Cabling."

3.06 FIRESTOPPING

- A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.07 PROTECTION

- A. Protect coatings, finishes, and cabinets from damage or deterioration.
 - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 - 2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 27 05 28

SECTION 27 05 29
HANGERS AND SUPPORTS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00:

1. Refer to "PART 2 – PRODUCTS" for all Buy America Build America Act (BABA) Requirements.

- B. Section Includes:

1. Steel slotted support systems for communication raceways.
2. Aluminum slotted support systems for communication raceways.
3. Nonmetallic slotted support systems for communication raceways.
4. Conduit and cable support devices.
5. Support for conductors in vertical conduit.
6. Structural steel for fabricated supports and restraints.
7. Mounting, anchoring, and attachment components, including powder-actuated fasteners, mechanical expansion anchors, concrete inserts, clamps, through bolts, toggle bolts, and hanger rods.
8. Fabricated metal equipment support assemblies.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:
 - a. Slotted support systems, hardware, and accessories.
 - b. Clamps.
 - c. Hangers.
 - d. Sockets.

- e. Eye nuts.
 - f. Fasteners.
 - g. Anchors.
 - h. Saddles.
 - i. Brackets.
- 2. Include rated capacities and furnished specialties and accessories.
- B. Shop Drawings: For fabrication and installation details for communications hangers and support systems.
- 1. Trapeze hangers. Include product data for components.
 - 2. Steel slotted-channel systems.
 - 3. Aluminum slotted-channel systems.
 - 4. Nonmetallic slotted-channel systems.
 - 5. Equipment supports.
 - 6. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

1.04 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
- 1. Suspended ceiling components.
 - 2. Ductwork, piping, fittings, and supports.
 - 3. Structural members to which hangers and supports will be attached.
 - 4. Size and location of initial access modules for acoustical tile.
 - 5. Items penetrating finished ceiling, including the following:
 - a. Luminaires.
 - b. Air outlets and inlets.
 - c. Speakers.
 - d. Sprinklers.

- e. Access panels.
 - f. Projectors.
6. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 7. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 8. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- B. Welding certificates.

1.05 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M.
- B. Welding Qualifications: Qualify procedures and personnel according to the following:
 1. AWS D1.1/D1.1M.
 2. AWS D1.2/D1.2M.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 1. Flame Rating: Class 1.
 2. Self-extinguishing according to ASTM D 635.

2.02 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Preformed steel channels and angles with minimum 13/32-inch-diameter holes at a maximum of 8 inches o.c. in at least one surface.
 1. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
 2. Material for Channel, Fittings, and Accessories: Galvanized steel.
 3. Channel Width: Selected for applicable load criteria.
 4. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.

5. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
 6. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
 7. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
 8. Channel Dimensions: Selected for applicable load criteria.
- B. Aluminum Slotted Support Systems: Extruded aluminum channels and angles with minimum 13/32-inch-diameter holes at a maximum of 8 inches o.c. in at least one surface.
1. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
 2. Channel Material: 6063-T6 aluminum alloy.
 3. Fittings and Accessories Material: 5052-H32 aluminum alloy.
 4. Channel Width: Selected for applicable load criteria.
 5. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
 6. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
 7. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
 8. Channel Dimensions: Selected for applicable load criteria.
- C. Nonmetallic Slotted Support Systems: Structural-grade, factory-formed, glass-fiber-resin channels and angles with minimum 13/32-inch-diameter holes at a maximum of 8 inches o.c., in at least one surface.
1. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
 2. Channel Width: Selected for applicable load criteria.
 3. Fittings and Accessories: Products provided by channel and angle manufacturer and designed for use with those items.
 4. Fitting and Accessory Materials: Same as those for channels and angles, except metal items may be stainless steel.
 5. Rated Strength: Selected to suit applicable load criteria.
 6. Protect finishes on exposed surfaces from damage by applying a strippable,

temporary protective covering before shipping.

- D. Conduit and Cable Support Devices: Steel and malleable-iron Stainless-steel clamps, hangers, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- E. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for nonarmored communications conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be made of malleable iron.
- F. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M steel plates, shapes, and bars; black and galvanized.
- G. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
 - 1. Powder-Actuated Fasteners: Threaded-steel stud for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 - 2. Concrete Inserts: Steel or malleable-iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58.
 - 3. Clamps for Attachment to Steel Structural Elements: MSS SP-58 units are suitable for attached structural element.
 - 4. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
 - 5. Toggle Bolts: Stainless-steel springhead type.
 - 6. Hanger Rods: Threaded steel.

PART 3 - EXECUTION

3.01 APPLICATION

- A. Comply with the following standards for application and installation requirements of hangers and supports, except where requirements on Drawings or in this Section are stricter:
 - 1. NECA 1.
 - 2. NECA/BICSI 568.
 - 3. TIA-569-D.
 - 4. NECA 101
 - 5. NECA 102.

6. NECA 105.
 7. NECA 111.
- B. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.
 - C. Comply with requirements for pathways specified in Section 270528 "Pathways for Communications Systems."
 - D. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMTs, IMCs, and RMCs as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.
 - E. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
 1. Secure raceways and cables to these supports with two-bolt conduit clamps.
 - F. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.02 SUPPORT INSTALLATION

- A. Raceway Support Methods: In addition to methods described in NECA 1, EMT and RMC may be supported by openings through structure members, according to NFPA 70.
- B. Strength of Support Assemblies: Where not indicated, select sizes of components, so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.
- C. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten communications items and their supports to building structural elements by the following methods unless otherwise indicated by code:
 1. To Wood: Fasten with lag screws or through bolts.
 2. To New Concrete: Bolt to concrete inserts.
 3. To Masonry: Use approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 4. To Existing Concrete: Use expansion anchor fasteners.
 5. Instead of expansion anchors, powder-actuated-driven threaded studs, provided with lock washers and nuts, may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete

or for slabs less than 4 inches thick.

6. To Steel: Spring-tension clamps.
 7. To Light Steel: Sheet metal screws.
 8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.
- D. Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.

3.03 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements in Section 055000 "Metal Fabrications" for site-fabricated metal supports.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor communications materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M.

END OF SECTION 27 05 29

SECTION 270536
CABLE TRAYS FOR COMMUNICATIONS SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Ladder cable tray.

1.02 RELATED WORK

A. SUMMARY OF WORK: Section 01 11 00:

1. Refer to "PART 2 – PRODUCTS" for all Buy America Build America Act (BABA) Requirements

1.03 ACTION SUBMITTALS

A. Product Data: For each type of cable tray.

1. Include data indicating dimensions and finishes for each type of cable tray indicated.

B. Shop Drawings: For each type of cable tray.

1. Show fabrication and installation details of cable trays, including plans, elevations, and sections of components and attachments to other construction elements. Designate components and accessories, including clamps, brackets, hanger rods, splice-plate connectors, expansion-joint assemblies, straight lengths, and fittings.

1.04 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans and sections, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Scaled cable tray layout and relationships between components and adjacent structural, electrical, and mechanical elements.
2. Vertical and horizontal offsets and transitions.
3. Clearances for access above and to side of cable trays.
4. Vertical elevation of cable trays above the floor or below bottom of ceiling structure.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS FOR CABLE TRAYS

- A. Cable Trays and Accessories: Identified as defined in NFPA 70 and marked for intended location, application, and grounding.
 - 1. Source Limitations: Obtain cable trays and components from single manufacturer.

2.02 LADDER CABLE TRAY

- A. Description:
 - 1. Configuration: Two (2) l-beam side rails with transverse rungs swaged or welded to side rails.
 - 2. Width: As indicated on Drawings.
 - 3. Straight Section Lengths: 10 feet (3.0 m), except where shorter lengths are required to facilitate tray assembly.
 - 4. Rung Spacing: 6 inches o.c.
 - 5. Radius-Fitting Rung Spacing: 9 inches (225 mm) at center of tray's width.
 - 6. Minimum Cable-Bearing Surface for Rungs: 7/8-inch (22-mm) width with radius edges.
 - 7. No portion of the rungs shall protrude below the bottom plane of side rails.
 - 8. Structural Performance of Each Rung: Capable of supporting a maximum cable load, with a safety factor of 1.5, plus a 200-lb (90-kg) concentrated load, when tested according to NEMA VE 1.
 - 9. Splicing Assemblies: Bolted type using serrated flange locknuts.
 - 10. Splice-Plate Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.

2.03 MATERIALS AND FINISHES:

- A. Aluminum Tray:
 - 1. Hardware: Chromium-zinc-plated steel, ASTM F 1136

2.04 CABLE TRAY ACCESSORIES

- A. Fittings: Tees, crosses, risers, elbows, and other fittings as indicated, of same materials and finishes as cable tray.
- B. Cable tray supports and connectors, including bonding jumpers, as recommended by cable tray manufacturer.

2.05 WARNING SIGNS

- A. Lettering: 1-1/2-inch-high, black letters on yellow background with legend "Warning! Not To Be Used as Walkway, Ladder, or Support for Ladders or Personnel.
- B. Comply with requirements for fasteners in Section 26 05 53 "Identification for Electrical Systems."

PART 3 EXECUTION

3.01 CABLE TRAY INSTALLATION

- A. Install cable trays according to NEMA VE 2.
- B. Install cable trays as a complete system, including fasteners, hold-down clips, support systems, barrier strips, adjustable horizontal and vertical splice plates, elbows, reducers, tees, crosses, cable dropouts, adapters, covers, and bonding.
- C. Install cable trays so that the tray is accessible for cable installation and all splices are accessible for inspection and adjustment.
- D. Remove burrs and sharp edges from cable trays.
- E. Join aluminum cable tray with splice plates; use four square neck-carriage bolts and locknuts.
- F. Fasten cable tray supports to building structure.
- G. Place supports so that spans do not exceed maximum spans on schedules and provide clearances shown on Drawings. Install intermediate supports when cable weight exceeds the load-carrying capacity of the tray rungs.
- H. Support bus assembly to prevent twisting from eccentric loading.
- I. Locate and install supports according to NEMA VE 2. Do not install more than one cable tray splice between supports.
- J. Make connections to equipment with flanged fittings fastened to cable trays and to equipment. Support cable trays independent of fittings. Do not carry weight of cable trays on equipment enclosure.
- K. Install expansion connectors where cable trays cross building expansion joints and in cable tray runs that exceed dimensions recommended in NEMA VE 2. Space connectors and set gaps according to applicable standard.
- L. Make changes in direction and elevation using manufacturer's recommended fittings.
- M. Make cable tray connections using manufacturer's recommended fittings.

- N. Seal penetrations through fire and smoke barriers. Comply with requirements in Section 078413 "Penetration Firestopping."
- O. Install cable trays with 12 inches above and 18 inches on one side for workspace to permit access for installing cables.
- P. Install warning signs in visible locations on or near cable trays after cable tray installation.

3.02 CABLE TRAY GROUNDING

- A. Ground cable trays according to NFPA 70 unless additional grounding is specified. Comply with requirements in Section 26 05 26 "Grounding and Bonding for Electrical Systems."
- B. Install #6 bare copper ground conductor on the exterior of the tray.
 - 1. Bond ground conductor to each section of tray via a listed device.
 - 2. Bond each conduit containing cables/conductors that transition into cable tray via a grounding bushing on the conduit and a #6 bare copper conductor to the ground conductor.
 - 3. Connect ground conductor to the equipment room ground bus.
 - 4. Do not cross over the cable tray with ground conductor or bond conductors.

3.03 CABLE INSTALLATION

- A. Install cables only when each cable tray run has been completed and inspected.
- B. Fasten cables on horizontal runs with cable clamps or cable ties according to NEMA VE 2. Tighten clamps only enough to secure the cable, without indenting the cable jacket. Install cable ties with a tool that includes an automatic pressure-limiting device.
- C. Fasten cables on vertical runs to cable trays every 18 inches (450 mm).
- D. Fasten and support cables that pass from one cable tray to another or drop from cable trays to equipment enclosures. Fasten cables to the cable tray at the point of exit and support cables independent of the enclosure. The cable length between cable trays or between cable tray and enclosure shall be no more than 24 inches.

3.04 CONNECTIONS

- A. Remove paint from all connection points before making connections. Repair paint after the connections are completed.
- B. Connect pathways to cable trays according to requirements in NEMA VE 2.

3.05 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:

1. After installing cable trays and after electrical circuitry has been energized, survey for compliance with requirements.
2. Visually inspect cable insulation for damage. Correct sharp corners, protuberances in cable trays, vibrations, and thermal expansion and contraction conditions, which may cause or have caused damage.
3. Verify that there are no intruding items such as pipes, hangers, or other equipment in the cable tray.
4. Remove dust deposits, industrial process materials, trash of any description, and any blockage of tray ventilation.
5. Visually inspect each cable tray joint and each ground connection for mechanical continuity. Check bolted connections between sections for corrosion. Clean and retorqued in suspect areas.
6. Check for improperly sized or installed bonding jumpers.
7. Check for missing, incorrect, or damaged bolts, bolt heads, or nuts. When found, replace with specified hardware.
8. Perform visual and mechanical checks for adequacy of cable tray grounding; verify that all takeoff raceways are bonded to cable trays. Test entire cable tray system for continuity. Maximum allowable resistance is 1 ohm.

3.06 PROTECTION

A. Protect installed cable trays and cables.

1. Install temporary protection for cables in open trays to safeguard exposed cables against falling objects or debris during construction. Temporary protection for cables and cable tray can be constructed of wood or metal materials and shall remain in place until the risk of damage is over.

END OF SECTION 27 05 36

SECTION 27 05 44
SLEEVES AND SLEEVE SEALS FOR COMMUNICATIONS PATHWAYS AND CABLING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Sleeves for pathway and cable penetration of non-fire-rated construction walls and floors.
2. Sleeve-seal systems.
3. Sleeve-seal fittings.
4. Grout.
5. Silicone sealants.

B. Related Requirements:

1. Division 07 Section "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

1.02 RELATED WORK

A. SUMMARY OF WORK: Section 01 11 00:

1. Refer to "PART 2 – PRODUCTS" for all Buy America Build America Act (BABA) Requirements.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.01 SLEEVES

A. Wall Sleeves:

1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral water stop unless otherwise indicated.

B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:

Galvanized-steel sheet; 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

- C. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.
- D. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.
- E. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.
- F. Sleeves for Rectangular Openings:
 - 1. Material: Galvanized-steel sheet.
 - 2. Minimum Metal Thickness:
 - a. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and with no side larger than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
 - b. For sleeve cross-section rectangle perimeter 50 inches (1270 mm) or more and one or more sides larger than 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

2.02 SLEEVE-SEAL SYSTEMS

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and pathway or cable.
 - 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 or Stainless steel.
 - 3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, Stainless steel of length required to secure pressure plates to sealing elements.

2.03 SLEEVE-SEAL FITTINGS

- A. Description: Manufactured plastic, sleeve-type, water stop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber water stop collar with center opening to match piping OD.

2.04 GROUT

- A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.
- B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- C. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

- D. Packaging: Premixed and factory packaged.

2.05 SILICONE SEALANTS

- A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.
 - 1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.
- B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

PART 3 - EXECUTION

3.01 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

- A. Comply with NEMA VE 2 for cable tray and cable penetrations.
- B. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:
 - 1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
 - a. Seal annular space between sleeve and pathway or cable, using joint sealant appropriate for size, depth, and location of joint.
 - b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall, so no voids remain. Tool exposed surfaces smooth; protect material while curing.
 - 2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
 - 3. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pathway or cable unless sleeve seal is to be installed.
 - 4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
 - 5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches (50 mm) Insert dimension above finished floor level. Install sleeves during erection of floors.
- C. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:
 - 1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
 - 2. Seal space outside of sleeves with approved joint compound for gypsum board

assemblies.

- D. Roof-Penetration Sleeves: Seal penetration of individual pathways and cables with flexible boot-type flashing units applied in coordination with roofing work.
- E. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- F. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between pathway or cable and sleeve for installing sleeve-seal system.

3.02 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at pathway entries into building.
- B. Install type and number of sealing elements recommended by manufacturer for pathway or cable material and size. Position pathway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pathway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.03 SLEEVE-SEAL-FITTING INSTALLATION

- A. Install sleeve-seal fittings in new walls and slabs as they are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position water stop flange to be centered in concrete slab or wall.
- C. Secure nailing flanges to concrete forms.
- D. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION 27 05 44

SECTION 27 11 00
COMMUNICATIONS EQUIPMENT ROOM FITTINGS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Telecommunications mounting elements.
2. Backboards.
3. Telecommunications equipment racks and cabinets.
4. Grounding

B. Related Requirements:

1. Section 270536 "Cable Trays for Communications Systems" for cable trays and accessories.
2. Section 280513 "Conductor and Cables for Electronic Safety and Security" for voice and data cabling associated with system panels and devices.

1.02 RELATED WORK

A. SUMMARY OF WORK: Section 01 11 00:

1. Refer to "PART 2 – PRODUCTS" for all Buy America Build America Act (BABA) Requirements.

1.03 DEFINITIONS

- A. BICSI: Building Industry Consulting Service International.
- B. LAN: Local area network.
- C. RCDD: Registered communications distribution designer.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for equipment racks and cabinets.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For communications equipment room fittings. Include plans, elevations,

sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Equipment Racks and Cabinets: Include workspace requirements and access for cable connections.
3. Grounding: Indicate location of grounding bus bar and its mounting detail showing standoff insulators and wall mounting brackets.

1.05 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.

1.06 QUALITY ASSURANCE

- A. Installer Qualifications: Cabling installer must have personnel certified by BICSI on staff.
 1. Layout Responsibility: Preparation of Shop Drawings shall be under direct supervision of RCDD.
 2. Installation Supervision: Installation shall be under direct supervision of Registered Technician who shall be present at all times when Work of this Section is performed at Project site.

PART 2 - PRODUCTS

2.01 BACKBOARDS

- A. Backboards: Plywood, 3/4 by 48 by 96 inches. Comply with requirements for plywood backing per EIA/TIA 569.
- B. Backboard Paint: Two (2) coats of light gray fire-retardant paint.

2.02 EQUIPMENT FRAMES

- A. General Frame Requirements:
 1. Distribution Frames: Freestanding modular-steel units designed for telecommunications terminal support and coordination with dimension of units to be supported.
 2. Module Dimension: Width compatible with EIA 310-D standard, 19-inch panel mounting.
 3. Finish: Manufacturer's standard, baked-polyester powder coat.
- B. Floor-Mounted Racks: Modular-type, steel or aluminum construction.

1. Vertical and horizontal cable management channels, top and bottom cable troughs, grounding lug.
 2. Baked-polyester powder coat finish.
- C. Cable Management for Equipment Frames:
1. Metal, with integral wire retaining fingers.
 2. Baked-polyester powder coat finish.
 3. Vertical cable management panels shall have front and rear 6-inch wide channels, with hinged swing gates for keeping cables in.
 4. Provide horizontal crossover cable manager at the top of each rack and below contractor installed device, with a minimum height of two rack units each. Cable supports to be offset opening rings with cable spools on ends.

2.03 GROUNDING

- A. Comply with requirements in Section 27 05 26 "Grounding and Bonding for Communications Systems" for grounding conductors and connectors.

PART 3 - EXECUTION

3.01 ENTRANCE FACILITIES

- A. Contact telecommunications service provider and arrange for installation of demarcation point, protected entrance terminals, and a housing when so directed by service provider.
- B. Comply with requirements in Section 27 05 28 "Pathways for Communications Systems" for materials and installation requirements for underground pathways.

3.02 INSTALLATION

- A. Comply with NECA 1.
- B. Comply with BICSI's "Telecommunications Distribution Methods Manual" for layout of communications equipment spaces.
- C. Comply with BICSI's "Information Technology Systems Installation Methods Manual" for installation of equipment in communications equipment spaces.
- D. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

3.03 SLEEVE AND SLEEVE SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 27 05 44 "Sleeves and Sleeve Seals for Communications Pathways and Cabling."

3.04 FIRESTOPPING

- A. Comply with requirements in Section 07 84 13 "Penetration Firestopping."
- B. Comply with TIA-569-D, Annex A, "Firestopping."
- C. Comply with BICSI's "Information Technology Systems Installation Methods Manual," "Firestopping Practices".

END OF SECTION 27 11 00

SECTION 27 15 13
COMMUNICATIONS COPPER HORIZONTAL CABLING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00:
 - 1. Refer to "PART 2 – PRODUCTS" for all Buy America Build America Act (BABA) Requirements.

1.03 SUMMARY

- A. Section Includes:
 - 1. Category 6E twisted pair cable.
 - 2. Twisted pair cable hardware, including plugs and jacks.
 - 3. Multiuser telecommunications outlet assembly.
 - 4. Cable management system.
 - 5. Cabling identification products.
 - 6. Grounding provisions for twisted pair cable.
 - 7. Source quality control requirements for twisted pair cable.

1.04 DEFINITIONS

- A. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.
- B. EMI: Electromagnetic interference.
- C. FTP: Shielded twisted pair.
- D. F/FTP: Overall foil screened cable with foil screened twisted pair.
- E. F/UTP: Overall foil screened cable with unscreened twisted pair.
- F. IDC: Insulation displacement connector.
- G. LAN: Local area network.

- H. Jack: Also commonly called an "outlet," it is the fixed, female connector.
- I. Plug: Also commonly called a "connector," it is the removable, male telecommunications connector.
- J. RCDD: Registered Communications Distribution Designer.
- K. Screen: A metallic layer, either a foil or braid, placed around a pair or group of conductors.
- L. Shield: A metallic layer, either a foil or braid, placed around a pair or group of conductors.
- M. S/FTP: Overall braid screened cable with foil screened twisted pair.
- N. S/UTP: Overall braid screened cable with unscreened twisted pairs.
- O. UTP: Unscreened (unshielded) twisted pair.

1.05 COPPER HORIZONTAL CABLING DESCRIPTION

- A. Horizontal cable cabling system shall provide interconnections between Distributor A, Distributor B, or Distributor C, and the equipment outlet, otherwise known as "Cabling Subsystem 1," in the telecommunications cabling system structure. Cabling system consists of horizontal cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for horizontal-to-horizontal cross-connection.
 - 1. TIA-568-C.1 requires that a minimum of two equipment outlets be installed for each work area.
 - 2. Horizontal cabling shall contain no more than one transition point or consolidation point between the horizontal cross-connect and the telecommunications equipment outlet.
 - 3. Bridged taps and splices shall not be installed in the horizontal cabling.
- B. A work area is approximately 100 sq. ft. (9.3 sq. m) and includes the components that extend from the equipment outlets to the station equipment.
- C. The maximum allowable horizontal cable length is 295 feet (90 m). This maximum allowable length does not include an allowance for the length of 16 feet (4.9 m) to the workstation equipment or in the horizontal cross-connect.

1.06 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Reviewed and stamped by RCDD.
 - 1. System Labeling Schedules: Electronic copy of labeling schedules that are part of the cabling and asset identification system of the software.
 - 2. Cabling administration Drawings and printouts.

3. Wiring diagrams and installation details of telecommunications equipment, to show location and layout of telecommunications equipment, including the following:
 - a. Telecommunications rooms plans and elevations.
 - b. Telecommunications pathways.
 - c. Telecommunications system access points.
 - d. Telecommunications grounding system.
 - e. Telecommunications conductor drop locations.
 - f. Typical telecommunications details.
 - g. Mechanical, electrical, and plumbing systems.
- C. Twisted pair cable testing plan.
- D. Samples: For telecommunications jacks and plugs, in specified finish, one for each type and configuration and faceplates for color selection and evaluation of technical features.

1.07 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For RCDD, Installer, installation supervisor, and field inspector.
- B. Product Certificates: For each type of product.
- C. Source quality-control reports.
- D. Field quality-control reports.

1.08 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For splices and connectors to include in maintenance manuals.
- B. Software and Firmware Operational Documentation:
 1. Software operating and upgrade manuals.
 2. Program Software Backup: On USB media or compact disk, complete with data files.
 3. Device address list.
 4. Printout of software application and graphic screens.

1.09 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Connecting Blocks two of each type.
2. Faceplates: One of each type.
3. Jacks: fifteen of each type.
4. Multiuser Telecommunications Outlet Assemblies: of each type.
5. Patch-Panel Units: two of each type.
6. Plugs: fifteen of each type.

1.10 QUALITY ASSURANCE

- A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
 1. Layout Responsibility: Preparation of Shop Drawings, cabling administration Drawings, and field-testing program development by an RCDD.
 2. Installation Supervision: Installation shall be under the direct supervision of Technician, who shall be always present when Work of this Section is performed at Project site.
 3. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.
- B. Testing Agency Qualifications: Testing agency must have personnel certified by BICSI on staff.
 1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD.

1.11 DELIVERY, STORAGE, AND HANDLING

- A. Test cables upon receipt at Project site.
 1. Test each pair of twisted pair cable for open and short circuits.

1.12 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.13 COORDINATION

- A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

1.14 SOFTWARE SERVICE AGREEMENT

- A. Technical Support: Beginning with Substantial Completion, provide software support for

two years.

- B. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software.
 - 1. Provide 30 days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment if necessary.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. General Performance: Horizontal cabling system shall comply with transmission standards in TIA-568-C.1, when tested according to test procedures of this standard.
- B. Telecommunications Pathways and Spaces: Comply with TIA-569-D.
- C. Grounding: Comply with TIA-607-B.

2.02 GENERAL CABLE CHARACTERISTICS

- A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with the applicable standard and NFPA 70 for the following types:
 - 1. Communications, Plenum Rated: Type CMP complying with UL 1685 or Type CMP in listed plenum communications raceway or Type CMP in listed cable routing assembly.
 - 2. Communications, Plenum Rated: Type CM, Type CMG, Type CMP, Type CMR, or Type CMX in metallic conduit installed according to NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."
 - 3. Communications, Non-plenum: Type CMR complying with UL 1666 and ICEA S-103-701.
 - 4. Communications, Non-plenum: Type CMP or Type CMR in listed plenum or riser communications raceway.
 - 5. Communications, Non-plenum: Type CMP or Type CMR in metallic conduit installed according to NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."
- B. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Flame-Spread Index: 25 or less.
 - 2. Smoke-Developed Index: 50 or less.
- C. RoHS compliant.

2.03 CATEGORY 6E TWISTED PAIR CABLE

- A. Description: Four-pair, balanced-twisted pair cable certified to meet transmission characteristics of Category 6E cable at frequencies up to 1Gig.
- B. Manufacturers
 - 1. Category 6E twisted pair cable. Basis of design: Panduit TX6000-Enhanced, PUP6004*-W for indoor plenum areas, and Panduit TX6E, PFO6X04*-CEG for outdoor areas.
 - 2. Other approved manufacturers: CommScope, Belden.
- C. Standard: Comply with TIA-568-C.2 for Category 6 cables.
- D. Conductors: 100-ohm, 23 AWG solid copper.
- E. Shielding/Screening: Unshielded twisted pairs (UTP).
- F. Cable Rating: Plenum, and OSP for exterior applications.

2.04 TWISTED PAIR CABLE HARDWARE

- A. Description: Hardware designed to connect, splice, and terminate twisted pair copper communications cable.
- B. Manufactures only manufactures offering certified partnered system solutions for structured cabling, that carry full manufacture warranty would be accepted. Panduit, Commscope, Belden and will ONLY be accepted unless noted otherwise. Contractor must only use one manufacture as a total installation solution.
 - 1. Products:
 - a. Horizontal Workstations outlets
 - (1) Check with manufacture on the part number required for jack color and category according to application as follows:
 - b. Blue Jacket and Blue Keystone: Data Drops
 - c. Yellow Jacket and Yellow Keystone: Surveillance Cameras.
 - d. White Jacket and White Keystone: Access Control systems
 - e. Faceplates single gang choose port capacity according to number of cables. Refer to other sections of division 27 for additional requirements.
 - f. Patch cords for telecommunications rooms. Use color according to application Category 6E. 8” long.
 - g. Patch cords for Workstation and users and users use color according to application. Category 6E. 10 ft long

- C. General Requirements for Twisted Pair Cable Hardware:
 - 1. Comply with the performance requirements of Category 6E.
 - 2. Comply with TIA-568-C.2, IDC type, with modules designed for punch-down caps or tools.
 - 3. Cables shall be terminated with connecting hardware of same category or higher.
- D. Source Limitations Obtain twisted pair cable hardware from same manufacturer as twisted pair cable, from single source.
- E. Connecting Blocks:
 - 1. 110-style IDC for Category 6E.
 - 2. Provide blocks for the number of cables terminated on the block, plus 25 percent spare, integral with connector bodies, including plugs and jacks where indicated.
- F. Cross-Connect: Modular array of connecting blocks arranged to terminate building cables and permit interconnection between cables.
 - 1. Number of Terminals per Field: One for each conductor in assigned cables.
- G. Patch Panel: Modular panels housing numbered jack units with IDC-type connectors at each jack location for permanent termination of pair groups of installed cables.
 - 1. Features:
 - a. Universal T568A and T568B wiring labels.
 - b. Labeling areas adjacent to conductors.
 - c. Replaceable connectors.
 - d. 24 or 48 ports.
 - 2. Construction: 16-gauge steel and mountable on 19-inch (483 mm) equipment racks.
 - 3. Number of Jacks per Field: One for each four-pair cable indicated Cords.
- H. Patch Cords: Factory-made, four-pair cables in 8-inch lengths; terminated with an eight-position modular plug at each end.
 - 1. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure performance. Patch cords shall have latch guards to protect against snagging.
 - 2. Patch cords shall have color-coded boots for circuit identification.
- I. Plugs and Plug Assemblies:

1. Male; eight position; color-coded modular telecommunications connector designed for termination of a single four-pair, 100-ohm, unshielded or shielded twisted pair cable.
2. Standard: Comply with TIA-568-C.2.
3. Marked to indicate transmission performance.

J. Jacks and Jack Assemblies:

1. Female; eight position; modular; fixed telecommunications connector designed for termination of a single four-pair, 100-ohm, unshielded or shielded twisted pair cable.
2. Designed to snap-in to a patch panel or faceplate.
3. Standard: Comply with TIA-568-C.2.
4. Marked to indicate transmission performance.

K. Faceplate:

1. Six port, vertical single gang faceplates designed to mount to single gang wall boxes.
2. Plastic Faceplate: High-impact plastic. Coordinate color with Section 262726 "Wiring Devices."
3. For use with snap-in jacks accommodating any combination of twisted pair, optical fiber, and coaxial work area cords.
 - a. Flush mounting jacks, positioning the cord at a 45-degree angle.

L. Legend:

1. Snap-in, clear-label covers and machine-printed paper inserts.

2.05 CABLE MANAGEMENT SYSTEM

- A. Description: Computer-based cable management system, with integrated database and graphic capabilities.
- B. Document physical characteristics by recording the network, TIA details, and connections between equipment and cable.
- C. Information shall be presented in database view, schematic plans, or technical drawings.
 1. Microsoft Visio Professional or AutoCAD drawing software shall be used as drawing and schematic plans software.
- D. System shall interface with the following testing and recording devices:

1. Direct upload tests from circuit testing instrument into the personal computer.
2. Direct download circuit labeling into labeling printer.

2.06 IDENTIFICATION PRODUCTS

- A. Comply with TIA-606-B and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

2.07 GROUNDING

- A. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems" for grounding conductors and connectors.
- B. Comply with TIA-607-B.

2.08 SOURCE QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to evaluate cables.
- B. Factory test cables on reels according to TIA-568-C.1.
- C. Factory test twisted pair cables according to TIA-568-C.2.
- D. Cable will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

PART 3 - EXECUTION

3.01 WIRING METHODS

- A. Wiring Method: Install cables in raceways and cable trays, except within consoles, cabinets, desks, and counters. Conceal raceway and cables, except in unfinished spaces.
 1. Install plenum cable in environmental air spaces, including plenum ceilings.
 2. Comply with requirements for raceways and boxes specified in Section 270528 "Pathways for Communications Systems."
- B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
- C. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools. Install conductors parallel with or at right angles to sides and back of enclosure.

3.02 INSTALLATION OF PATHWAYS

- A. Coordinate cable-connection hardware installations and specialty arrangements with layout

Drawings and with requirements specified for communications equipment rooms. If Drawings are explicit enough, these requirements may be reduced or omitted.

- B. Comply with requirements for demarcation point, cabinets, and racks specified in Section 271100 "Communications Equipment Room Fittings."
- C. Comply with Section 270528 "Pathways for Communications Systems."
- D. Comply with Section 270529 "Hangers and Supports for Communications Systems."
- E. Drawings indicate general arrangement of pathways and fittings.

3.03 INSTALLATION OF TWISTED-PAIR HORIZONTAL CABLES

- A. Comply with NECA 1 and NECA/BICSI 568.
- B. General Requirements for Cabling:
 - 1. Comply with TIA-568-C.0, TIA-568-C.1, and TIA-568-C.2.
 - 2. Comply with BICSI's "Information Transport Systems Installation Methods Manual (ITSIMM), Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section.
 - 3. Install 110-style IDC termination hardware unless otherwise indicated.
 - 4. Do not untwist twisted pair cables more than 1/2 inch (12 mm) from the point of termination to maintain cable geometry.
 - 5. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
 - 6. MUTOA shall not be used as a cross-connect point.
 - 7. Consolidation points may be used only for making a direct connection to equipment outlets:
 - a. Do not use consolidation point as a cross-connect point, as a patch connection, or for direct connection to workstation equipment.
 - b. Locate consolidation points for twisted-pair cables at least 49 feet (15 m) from communications equipment room.
 - 8. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
 - 9. Install lacing bars to restrain cables, prevent straining connections, and prevent bending cables to smaller radii than minimums recommended by manufacturer.
 - 10. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in

BICSI Information Transport Systems Installation Methods Manual , Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section. Use lacing bars and distribution spools.

11. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation, and replace it with new cable.
 12. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
 13. In the communications equipment room, install a 10-foot- (3-m-) long service loop on each end of cable.
 14. Pulling Cable: Comply with BICSI Information Transport Systems Installation Methods Manual, Ch. 5, "Copper Structured Cabling Systems," "Pulling and Installing Cable" Section. Monitor cable pull tensions.
- C. Open-Cable Installation:
1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
 2. Suspend twisted pair cabling, not in a wireway or pathway, a minimum of 8 inches (200 mm) above ceilings by cable supports not more than 60 inches (1524 mm) apart.
 3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.
- D. Group connecting hardware for cables into separate logical fields.
- E. Separation from EMI Sources:
1. Comply with recommendations from BICSI's "Telecommunications Distribution Methods Manual" and TIA-569-D for separating unshielded copper communication cable from potential EMI sources, including electrical power lines and equipment.
 2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches (127 mm).
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches (300 mm).
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches (600 mm).

3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches (64 mm).
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches (150 mm).
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches (300 mm).
4. Separation between communications cables in grounded metallic raceways, power lines, and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches (76 mm).
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches (150 mm).
5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches (1200 mm).
6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches (127 mm).

3.04 FIRESTOPPING

- A. Comply with TIA-569-D, Annex A, "Firestopping."
- B. Comply with "Firestopping Systems" Article in BICSI's "Telecommunications Distribution Methods Manual."

3.05 GROUNDING

- A. Install grounding according to the "Grounding, Bonding, and Electrical Protection" chapter in BICSI's "Telecommunications Distribution Methods Manual."
- B. Comply with TIA-607-B and NECA/BICSI-607.
- C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall, allowing at least a 2-inch (50-mm) clearance behind the grounding bus bar. Connect grounding bus bar to suitable electrical building ground, using a minimum No. 4 AWG grounding electrode conductor.
- D. Bond metallic equipment to the grounding bus bar, using not smaller than a No. 6 AWG equipment grounding conductor.

3.06 IDENTIFICATION

- A. Identify system components, wiring, and cabling complying with TIA-606-B.
 - 1. Administration Class: Class 3
 - 2. Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.
- B. Paint and label colors for equipment identification shall comply with TIA-606-B for Class 3 level of administration, including optional identification requirements of this standard.
- C. Cable Schedule: Install in a prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.
- D. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.
- E. Cable and Wire Identification:
 - 1. Label each cable within 4 inches (100 mm) of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
 - 2. Each wire connected to building-mounted devices is not required to be numbered at the device if wire color is consistent with associated wire connected and numbered within panel or cabinet.
 - 3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet (4.5 m).
 - 4. Label each terminal strip, and screw terminal in each cabinet, rack, or panel.
 - a. Individually number wiring conductors connected to terminal strips, and identify each cable or wiring group, extended from a panel or cabinet to a building-mounted device, with the name and number of a particular device.
 - b. Label each unit and field within distribution racks and frames.
 - 5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and -connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.
- F. Labels shall be preprinted or computer-printed type, with a printing area and font color that contrast with cable jacket color but still comply with TIA-606-B requirements for the

following:

1. Cables use flexible vinyl or polyester that flexes as cables are bent.

3.07 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- D. Perform tests and inspections with the assistance of a factory-authorized service representative.
- E. Tests and Inspections:
 1. Visually inspect jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments and inspect cabling connections for compliance with TIA-568-C.1.
 2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
 3. Test twisted pair cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.
 - a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
- F. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similarly to Table 10.1 in BICSI's "Telecommunications Distribution Methods Manual," or shall be transferred from the instrument to the computer, saved as text files, printed, and submitted.
- G. Remove and replace cabling where test results indicate that they do not comply with specified requirements.
- H. End-to-end cabling will be considered defective if it does not pass tests and inspections.
- I. Prepare test and inspection reports.

3.08 SOFTWARE SERVICE AGREEMENT

- A. Technical Support: Beginning with Substantial Completion, provide software support for two years.
- B. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software.
 - 1. Provide 30days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment if necessary.

END OF SECTION 27 15 13

SECTION 27 21 00
DATA COMMUNICATION NETWORK EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

- A. The contractor shall supply, configure, and deploy Local Area Network (LAN) switches for the ECRC/Escambia County TMC. These switches must support current and future communication system requirements. They shall be stackable and power redundant enterprise access switches, capable of providing a unified management interface for up to 448 access ports.
- B. The contractor is responsible for the network switch configuration design and shall ensure the network configuration is optimized for the business and security networks, incorporating encryption, security measures, VLAN separation, QoS, and high availability.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00:
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) Requirements.

1.03 NETWORK SWITCH PERFORMANCE REQUIREMENTS

- A. Full compliance with IEEE 802.3.
- B. Support secure Wi-Fi 7 high speed access.
- C. Standards supported should include, but be not limited to, IEEE 802.3, 10BASET, IEEE 802.3u, 100BaseTX, 1000BaseFX, IEEE 802.11, IEEE 802.3ae-2002, Ethernet MIB (RFC 1643), SNMP MIB II (RFC 1213).
- D. Switch shall support UPOE+ 90W IEEE 802.3bt type 4 on 21 of the 48 ports. 48 port UPOE+, 48x 10G Multigigabit (10G/5G/2.5G/1G/100M).
- E. Secure Internet Gateway, Cloud Service Providers and Site to Site connectivity using IPsec tunnel with AES-256 Encryption and speeds up to 100G.
- F. x86 CPU complex with 8-GB memory, and 16 GB of flash and external USB 3.0 SSD pluggable storage slot (delivering up to 240GB of storage with an option SSD drive) to host containers.
- G. IEEE 802.1ba AV Bridging (AVB) built in to provide a better audio and video experience through improved time synchronization and QoS.
- H. AES-256 with MACsec 256-bit encryption IEEE 802.1AE standard for authenticating and encrypting packets between switches.

- I. End-to-end encrypted traffic between sites and connectivity to the Cloud.
- J. Switch shall include the optional network modules for uplink ports.
- K. Switch shall use dual power supplies and support high-availability features.

1.04 NETWORK SWITCH MANAGEMENT

- A. Basic configuration capability via local management page.
- B. Detailed historical per-port and per-client usage statistics.
- C. Operating System, device, and hostname fingerprinting.
- D. Automatic firmware upgrades with scheduling control.
- E. SNMP and SYSLOG support for integration with other network management solutions.

1.05 NETWORK SWITCH DIAGNOSTICS

- A. Email, SMS and Mobile push notification alerts¹.
- B. Ping, traceroute, cable testing, and link failure detection with alerting.
- C. Remote packet capture.
- D. Dynamic and interactive network discovery and topology.
- E. Combined event and configuration change logs with instant search.

1.06 ETHERNET SWITCHING CAPABILITIES

- A. 802.1p Quality of Service, 8 queues (w/ 6 configurable for DSCP-to-CoS mapping)
- B. 802.1Q VLAN and trunking support for up to 4,094 VLANs (1000 active VLANs with STP enabled)
- C. Single Instance of 802.1s Multiple Spanning Tree Protocol (interoperable with RSTP, STP, PVST, RPVST)
- D. STP Enhancements: BPDU guard, Root guard, Loop guard, UDLD
- E. Broadcast storm control
- F. 802.1ab Link Layer Discovery Protocol (LLDP) and Cisco Discovery Protocol (CDP)
- G. 802.3ad Link aggregation with up to 8 ports per aggregate, multi-chassis aggregates supported on stacked switches
- H. Port mirroring
- I. IGMP snooping for multicast filtering
- J. MAC Forwarding Entries: 32K

1.07 NETWORK SWITCH SECURITY

- A. Integrated multi-factor authentication for Dashboard management
- B. Role-based access control (RBAC) with granular device and configuration control
- C. Corporate wide password policy enforcement
- D. IEEE 802.1X RADIUS and MAB, hybrid authentication and RADIUS server testing
- E. Single-Host/Multi-Domain/Multi-Host/Multi Authentication
- F. Port security: Sticky MAC, MAC allow list
- G. DHCP snooping, detection and blocking, Dynamic ARP Inspection
- H. IPv4 and IPv6 ACLs
- I. Adaptive Policy

1.08 CONTRACTOR QUALIFICATIONS

- A. The contractor must hold certification from the manufacturer of the products to be installed. The contractor shall be specialized in network design and configuration of the products to be installed. The contractor shall follow the manufacturer's installation and testing procedures and use authorized manufacturer components and distribution channels for this project.
- B. All installation team members must be certified by the manufacturer(s) for completing the required training for their installation roles. Each team member shall have at least three years of experience installing the product in highly complex networks.
- C. Contractor shall provide five references for projects of approved equivalent scope, type and complexity of work completed within the last five years.

1.09 MAINTENANCE AND SUPPORT

- A. Provide the manufacturer's standard maintenance and support services for all hardware and software associated with this system at no additional charge for a period of not less than three years. It will be the responsibility of the contractor to provide the support of the installed network switch equipment.
- B. All lead technicians performing maintenance shall have a minimum of three years' experience on the proposed system and be manufacturer certified on all hardware/software applications.

1.10 MANUFACTURER'S WARRANTY

- A. Manufacturer's standard warranty in which manufacturer agrees to Next-Business-Day (NBD) replacement hardware where available and 90 days of 8x5 Technical Assistance Center (TAC) support.

1.11 EXTENDED WARRANTY

- A. Provide the manufacturer's extended warranty for all network switch equipment installed at no additional charge for a period of not less than three years. The warranty shall ensure that the installed equipment will conform to its description and any applicable specifications.

PART 2 - PRODUCT

2.01 NETWORK SWITCH

- A. LAN Equipment shall be Enterprise level high performance switch designed for complex corporate networks offering advanced features and robust management capabilities to handle heavy traffic and security needs.
- B. All LAN equipment shall provide Internet Protocol (IP) switching across all types of network technologies and topologies.
- C. Each active device shall be accessible from a network or console, or RS-232 port. A configuration specialist shall be able to enter supervisory mode and change configurations as appropriate for required operation of special system components.
- D. All active LAN devices shall include all software as required for interconnectivity. All active devices shall have fully functional network management options installed.
- E. No equipment shall be purchased if it is on the manufacture's "end of life" or "end of support list" in the next year.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. The Contractor shall Install components in accordance with contract drawings and manufacturer's instructions.
- B. The Contractor shall install all system components in accordance with the manufacturer's instructions, and adjustments required for a complete and operable system.
- C. Grounding shall be installed as necessary to preclude ground loops, noise, and surges from adversely affecting system operation by the contractor.
- D. The Contractor shall be responsible for any and all loss or damage in the shipment and delivery of all material until transfer to ECRC/Escambia County TMC.

END OF SECTION 27 21 00

SECTION 27 21 33
DATA COMMUNICATIONS WIRELESS ACCESS POINTS

PART 1 - GENERAL

1.01 ENTERPRISE-CLASS WIRELESS ACCESS COVERAGE

- A. All new construction projects involving wireless technology shall be coordinated with a owner representative. It is the responsibility of the contractor to provide an onsite wireless site survey with wireless map and heat map to determine optimal placement of the Wireless Access Point (WAP). The owner representative will review and approve the wireless design.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00:
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) Requirements.

1.03 PERFORMANCE REQUIREMENTS

- A. Wireless network will support Wi-Fi 7 (802.11be) capabilities with 4x4 Tri-Radio or Quad-Radio for 2.4GHz, 5 and 6 GHz wireless technologies. WAP shall provide a maximum of 24 Gbps aggregate frame rate with concurrent 2.4 GHz, 5 GHz, and 6 GHz radios. A dedicated fourth radio provides real-time WIDS/WIPS with automated RF optimization, and a fifth integrated IoT radio delivers Bluetooth scanning and beaconing. WAP shall support throughput speeds up to 11Gbps in 6Ghz, 5Gbps in 5Ghz, and 688Mbps at 2.4Ghz bands.
- B. Network Wireless Design shall conform with TIA/TSB 162 specifications and ANSI/BICSI 006 Wireless Design. Reference Manual (WDRM), most recent Edition.
- C. WAP power is Universal Power-Over-Ethernet (UPoE).
- D. All WAP cable and jack are for the exclusive use of the facility Network Services.
- E. The Network RJ45-2-Port Wall-Mount Biscuit Network Ethernet UTP LAN Jack White (Biscuit) shall be at ceiling level. The Biscuit shall not be higher than 20ft.
- F. The location of the WAP is based on the room design and Wireless Site Survey results.
- G. The WAP Network shall use a centralized management service that allows management of the WAP devices via a single simple and secure platform. The centralized management service shall allow users to deploy, monitor, and configure the devices via a dashboard web interface or via API's.
- H. The data that flows from the WAP to the management service shall be over a secure internet connection.
- I. The wireless solution shall use an event-driven remote procedure call (RPC) engine to

communicate to the dashboard and remote servers to send and receive data. The cloud infrastructure is the initiator, so configurations can be executed in the cloud before the WAP's are online or physically deployed.

- J. Cloud communication shall use a proprietary encrypted tunnel using AES-256 encryption while management data is in transit.

1.04 ACCESS POINT SPECIFICATIONS

A. Radios

1. Tri-radio mode (Default):
 - a. 2.4 GHz 802.11 b/g/n/ac/ax/be client access radio
 - b. 5 GHz 802.11 a/n/ac/ax/be client access radio
 - c. 6 GHz 802.11 ax/be client access radio
2. Quad-radio mode:
 - a. 2.4 GHz 802.11 b/g/n/ac/ax/be client access radio
 - b. 5 GHz 802.11 a/n/ac/ax/be client access radio (UNII-1 & 2 bands)
 - c. 5 GHz 802.11 a/n/ac/ax/be client access radio (UNII-2E & 3 bands)
 - d. 6 GHz 802.11 ax/be client access radio
3. 2.4 GHz, 5 GHz, and 6 GHz tri-band Air Marshal WIDS/WIPS, spectrum analysis, & location analytics radio
4. 2.4 GHz Bluetooth Low Energy (BLE) radio with Beacon and BLE scanning support Concurrent operation of all five radios. BLE version (5.3), software upgradable to 6.0 in the future.
5. Supported frequency bands (country-specific restrictions apply):
 - a. 2.401 - 2.484 GHz
 - b. 5.150 - 5.250 GHz (UNII-1)
 - c. 5.250 - 5.350 GHz (UNII-2A)
 - d. 5.490 - 5.730 GHz (UNII-2C)
 - e. 5.735 -5.825 GHz (UNII-3)

B. GPS

1. Built-in GPS/ GNSS

C. Antenna

1. 2.4-GHz: Peak gain 4 dBi, internal antenna, omnidirectional in azimuth
 2. 5-GHz: Peak gain 5 dBi, internal antenna, omnidirectional in azimuth
 3. 6-GHz: Peak gain 6 dBi, internal antenna, omnidirectional in azimuth
- D. 802.11ax, 802.11ac Wave 2 and 802.11n Capabilities
1. DL-OFDMA, UL-OFDMA, TWT support, BSS coloring
 2. 4 x 4 multiple input, multiple output (MIMO) with four spatial streams
 3. SU-MIMO, UL MU-MIMO, and DL MU-MIMO support
 4. Maximal ratio combining (MRC) & beamforming
 5. 20 and 40 MHz channels (802.11n); 20, 40 and 80 MHz channels (802.11ac Wave 2); 20, 40 and 80 MHz channels (802.11ax)
 6. Up to 1024-QAM on both 2.4 GHz and 5 GHz bands
 7. Packet aggregation
- E. 802.11be Capabilities
1. Up to 4096-QAM on 2.4 GHz, 5 GHz and 6 GHz bands
 2. 20 MHz channels on 2.4 GHz bands
 3. 20, 40, 80, 160 MHz on 5 GHz bands
 4. 20, 40, 80, 160, 320 MHz on 6 GHz bands
 5. MLO (Multi-link operation) across different bands
 6. MRU (Multiple Resource Unit) allocation in OFDMA
 7. 4 x 4 multiple input, multiple output (MIMO) with four spatial streams
- F. Power
1. Power over Ethernet: 802.3bt/ 802.3at/ 802.3af
 2. Power reservation: 60W max (802.3bt required for full operation)
 3. Power over Ethernet injector sold separately
- G. Interfaces
1. 2x 100M/ 1G/ 2.5G/ 5G/ 10G BASE-T Ethernet (RJ45)
 2. Management console port (RJ-45)
 3. USB 2.0 at 9W

H. Mounting

1. All standard mounting hardware included
2. Desktop, ceiling, and wall mount capable
3. Ceiling tile rail (9/16, 15/16 or 1 1/2" flush or recessed rails), assorted cable junction boxes

I. Environment

1. Nonoperating (storage) temperature: -22° to 158°F (-30° to 70°C)
2. Nonoperating (storage) altitude test: 25°C (77°F) at 15,000 ft (4570 m)
3. Operating temperature: 32° to 122°F (0° to 50°C)
4. Operating humidity: 10% to 90% (noncondensing)
5. Operating altitude test: 40°C (104°F) at 9843 ft (3000 m)
6. Humidity: 10% to 90% non-condensing

J. Reliability

1. Mean time between failure (MTBF): 942,282 hrs at +25°C operating temperature

K. Security

1. Integrated Layer 7 firewall with mobile device policy management
2. Real-time WIDS/WIPS with alerting and automatic rogue AP containment with Air Marshal
3. Flexible guest access with device isolation
4. VLAN tagging (802.1q) and tunneling with IPsec VPN
5. PCI compliance reporting
6. WPA2-PSK, WPA2-Enterprise, WPA3 - Personal, WPA3 - Enterprise, WPA3 - Enhanced Open (OWE)
7. EAP Local authentication - EAP-TTLS/PAP, PEAP-GTC, EAP-TLS
8. Advanced Encryption Standard (AES)
9. Enterprise Mobility Management (EMM) & Mobile Device Management (MDM) integration
10. Cisco ISE integration for Guest access and BYOD Posturing

L. Quality of Service

1. Advanced power save (U-APSD)
2. WMM access categories with DSCP and 802.1p support
3. Layer 7 application traffic identification and shaping

M. Warranty

1. Indoor access point
2. Lifetime hardware warranty with advanced replacement included

N. Access Point License

1. 3-year subscription

1.05 COMPLIANCE AND STANDARDS

A. IEEE Standards

1. 802.3 ab/bz
2. 802.3 af/at/bt
3. 802.11a/b/g/n/ac/ax/be
4. 802.11d/h/i/k/r/u/v/w

B. Certifications

1. Wi-Fi Alliance: Wi-Fi 7 (R1), Wi-Fi 6 (R2), Wi-Fi 6E, WPA3-R3, WPA3-Suite B, Enhanced Open Security
2. Bluetooth SIG: Bluetooth Low Energy

C. Safety Approvals

1. CSA and CB 60950 & 62368
2. EN 60601 certified
3. Conforms to UL 2043 (Plenum Rating)

D. Radio Approvals

1. FCC Part 15C
2. EN 300 328 (v2.1.1)
3. EN 301 893 (v2.1.1)

E.

END OF SECTION 27 21 33

SECTION 28 05 13
CONDUCTORS AND CABLES FOR ELECTRONIC SAFETY AND SECURITY

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. UTP cabling.
 - 2. RS-485 cabling.
 - 3. Low-voltage control cabling.
 - 4. Identification products.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00:
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) Requirements.

1.03 DEFINITIONS

- A. BICSI: Building Industry Consulting Service International.
- B. EMI: Electromagnetic interference.
- C. IDC: Insulation displacement connector.
- D. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control and signaling power-limited circuits.
- E. RCDD: Registered Communications Distribution Designer.

1.04 SUBMITTALS

- A. Product Data: For each type of product indicated.
 - 1. For low voltage cable, include the following installation data for each type used:
 - a. Nominal OD.
 - b. Minimum bending radius.
 - c. Maximum pulling tension.
- B. Shop Drawings: Cable layout, showing cable route to scale, with relationship between the

cable and adjacent structural, electrical, and mechanical elements. Include the following:

1. Vertical and horizontal offsets and transitions.
 2. Clearances for access above and to side of cable trays.
 3. Vertical elevation of cable trays above the floor or bottom of ceiling structure.
- C. Qualification Data: For qualified layout technician, installation supervisor, and field inspector.
- D. Source quality-control reports.
- E. Field quality-control reports.
- F. Operation and Maintenance Data: For wire and cable to include in operation and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
1. Allowable pulling tension of cable.
 2. Cable connectors and terminations recommended by the manufacturer.

1.05 QUALITY ASSURANCE

- A. Testing Agency Qualifications:
1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.
- B. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
1. Flame-Spread Index: 25 or less.
 2. Smoke-Developed Index: 450 or less.
- C. 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.

1.06 PROJECT CONDITIONS

- A. Do not install conductors and cables that are wet, moisture damaged, or mold damaged.
1. Indications that wire and cables are wet or moisture damaged include, but are not limited to, discoloration and sagging of factory packing materials.
- B. Environmental Limitations: Do not deliver or install UTP, optical fiber, and coaxial cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

PART 2 - PRODUCTS

2.01 PATHWAYS

- A. Support of Open Cabling: NRTL labeled for support of Category 6 cabling, designed to prevent degradation of cable performance and pinch points that could damage cable.
 - 1. Support brackets with cable tie slots for fastening cable ties to brackets.
 - 2. Lacing bars, spools, J-hooks, and D-rings.
 - 3. Straps and other devices.
- B. Conduit and Boxes: Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems. Flexible metal conduit shall not be used.
- C. Outlet boxes shall be no smaller than 2 inches (50 mm) wide, 3 inches (75 mm) high, and 2-1/2 inches (64 mm) deep.

2.02 BACKBOARDS

- A. Backboards: Plywood, two (2) coats of light gray fire-retardant treated, 3/4 by 48 by 96 inches. Comply with requirements for plywood backing per EIA/TIA 569.

2.03 UTP CABLE

- A. Description: 100-ohm, 4-pair UTP, covered with a blue thermoplastic jacket.
 - 1. Comply with ICEA S-90-661 for mechanical properties.
 - 2. Comply with ANSI/TIA-568-D.1 for performance specifications.
 - 3. Comply with ANSI/TIA-568-D.2, Category 6.
 - 4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:
 - a. Communications, General Purpose: Type CM or CMG.
 - b. Communications, Plenum Rated: Type CMP or MPP, complying with NFPA 262.
 - c. Communications, Riser Rated: Type CMR complying with UL 1666.
 - d. Multipurpose: Type MP or MPG; or MPP or MPR.
 - e. Multipurpose, Plenum Rated: Type MPP, complying with NFPA 262.
 - f. Multipurpose, Riser Rated: Type MPR, complying with UL 1666.

2.04 UTP CABLE HARDWARE

- A. UTP Cable Connecting Hardware: IDC type, using modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of the same category or higher.

2.05 RS-485 CABLE

- A. Standard Cable: NFPA 70, Type CM or CMG.
 - 1. Paired, 2 pairs, twisted, No. 22 AWG, stranded (7x30) tinned copper conductors.
 - 2. PVC insulation.
 - 3. Unshielded.
 - 4. PVC jacket.
 - 5. Flame Resistance: Comply with UL 1581.
- B. Plenum-Rated Cable: NFPA 70, Type CMP.
 - 1. Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors.
 - 2. Fluorinated ethylene propylene insulation.
 - 3. Unshielded.
 - 4. Fluorinated ethylene propylene jacket.
 - 5. Flame Resistance: NFPA 262, Flame Test.

2.06 LOW-VOLTAGE CONTROL CABLE

- A. Paired Cable: NFPA 70, Type CMG.
 - 1. 1 pair, twisted, No. 16 AWG, stranded (19x29) and No. 18 AWG, stranded (19x30) tinned copper conductors.
 - 2. PVC insulation.
 - 3. Unshielded.
 - 4. PVC jacket.
 - 5. Flame Resistance: Comply with UL 1581.
- B. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.
 - 1. 1 pair, twisted, No. 16 AWG, stranded (19x29) and No. 18 AWG, stranded (19x30) tinned copper conductors.

2. PVC insulation.
3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with NFPA 262.

2.07 IDENTIFICATION PRODUCTS

- A. Comply with UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.
- B. Comply with requirements in Division 26 Section "Identification for Electrical Systems."

2.08 SOURCE QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to evaluate cables.
- B. Factory test UTP and optical fiber cables on reels according to ANSI/TIA-568-D.1.
- C. Factory test UTP cables according to ANSI/TIA-568-D.2.
- D. Cable will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

PART 3 - EXECUTION

3.01 INSTALLATION OF PATHWAYS

- A. Comply with ANSI/TIA-569-D for pull-box sizing and length of conduit and number of bends between pull points.
- B. Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems." for installation of conduits and wireways.
- C. Install manufactured conduit sweeps and long-radius elbows whenever possible.
- D. Pathway Installation in Equipment Rooms:
 1. Position conduit ends adjacent to a corner on backboard where a single piece of plywood is installed or in the corner of room where multiple sheets of plywood are installed around perimeter walls of room.
 2. Install cable trays to route cables if conduits cannot be located in these positions.
 3. Secure conduits to backboard when entering room from overhead.
 4. Extend conduits 3 inches (75 mm) above finished floor.

5. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.
- E. Backboards: Install backboards with 96-inch (2440-mm) dimension vertical. Butt adjacent sheets tightly, and form smooth gap-free corners and joints.

3.02 INSTALLATION OF HANGERS AND SUPPORTS

- A. Comply with requirements in Division 26 Section "Hangers and Supports for Electrical Systems." for installation of supports for pathways, conductors and cables.

3.03 WIRING METHOD

- A. Install wiring in metal raceways and wireways. Conceal raceway except in unfinished spaces and as indicated. Minimum conduit size shall be 1 inch. Control and data transmission wiring shall not share conduit with other building wiring systems.
- B. Install wiring in raceways except in accessible indoor ceiling spaces and in interior hollow gypsum board partitions where cable may be used. Conceal raceways and wiring except in unfinished spaces and as indicated. Minimum conduit size shall be 1 inch. Control and data transmission wiring shall not share conduit with other building wiring systems.
- C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Use lacing bars and distribution spools. Separate power-limited and non-power-limited conductors as recommended in writing by manufacturer. Install conductors parallel with or at right angles to sides and back of enclosure. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with intrusion system to terminal blocks. Mark each terminal according to system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

3.04 INSTALLATION OF CONDUCTORS AND CABLES

- A. Comply with NECA 1.
- B. Conductors: Size according to system manufacturer's written instructions unless otherwise indicated.
- C. General Requirements for Cabling:
 1. Comply with ANSI/TIA-568-D.1.
 2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
 3. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.
 4. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
 5. Bundle, lace, and train conductors to terminal points without exceeding

manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Install lacing bars and distribution spools.

6. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
 7. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
 8. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.
- D. UTP Cable Installation: Install using techniques, practices, and methods that are consistent with Category 6 rating of components and that ensure Category 6 performance of completed and linked signal paths, end to end.
1. Comply with ANSI/TIA-568-D.2.
 2. Install 110-style IDC termination hardware unless otherwise indicated.
 3. Do not untwist UTP cables more than 1/2 inch (12 mm) from the point of termination to maintain cable geometry.
- E. Open-Cable Installation:
1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
 2. Suspend copper cable not in a wireway or pathway a minimum of 8 inches (200 mm) above ceilings by cable supports not more than 60 inches (1525 mm) apart.
 3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.
- F. Separation from EMI Sources:
1. Comply with BICSI TDMM and ANSI/TIA-569-D recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
 2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches (127 mm).
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches (300 mm).

- c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches (600 mm).
3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches (64 mm).
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches (150 mm).
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches (300 mm).
4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches (75 mm).
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches (150 mm).
5. Separation between Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches (1200 mm).
6. Separation between Cables and Fluorescent Fixtures: A minimum of 5 inches (127 mm).

3.05 POWER AND CONTROL-CIRCUIT CONDUCTORS

- A. 120-V Power Wiring: Install according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables" unless otherwise indicated.
- B. Minimum Conductor Sizes:
 1. Class 1 remote-control and signal circuits, No. 14 AWG.
 2. Class 2 low-energy, remote-control and signal circuits, No. 16 AWG.
 3. Class 3 low-energy, remote-control, alarm and signal circuits, No. 12 AWG.

3.06 FIRESTOPPING

- A. Comply with requirements in Division 07 Section "Penetration Firestopping."
- B. Comply with ANSI/TIA-569-D, "Firestopping" Annex A.

- C. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.07 GROUNDING

- A. For communications wiring, comply with ANSI/TIA J-STD-607-C and with BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.
- B. For low-voltage wiring and cabling, comply with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems."

3.08 IDENTIFICATION

- A. Identify system components, wiring, and cabling complying with ANSI/TIA-606-C. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.09 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform tests and inspections.
- C. Tests and Inspections:
 - 1. Visually inspect UTP and optical fiber cable jacket materials for NRTL certification markings. Inspect cabling terminations to confirm color-coding for pin assignments, and inspect cabling connections to confirm compliance with ANSI/TIA-568-D.1.
 - 2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
 - 3. Test UTP cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross connection.
 - a. Test instruments shall meet or exceed applicable requirements in ANSI/TIA-568-D.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
- D. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide or transfer the data from the instrument to the computer, save as text files, print, and submit.
- E. End-to-end cabling will be considered defective if it does not pass tests and inspections.
- F. Prepare test and inspection reports.

END OF SECTION 28 05 13

SECTION 28 13 00
ACCESS CONTROL SOFTWARE AND SECURITY DATABASE MANAGEMENT

PART 1 – GENERAL

1.01 SUMMARY

- A. Related Requirements:
 - 1. Division 08 – Door hardware
 - 2. Section 28 23 00 “Video Management System”.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00:
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) Requirements.

1.03 DEFINITIONS

- A. ACS – Access Control System
- B. CSA – Client Software Application
- C. DGM – Dynamic Graphical Maps
- D. ALPR – Automatic License Plate Recognition
- E. SDK – Software Development Kit
- F. GLM – Genetec Lifecycle Management
- G. SSM – Server Software Module
- H. UI – User Interface
- I. USP – Unified Security Platform
- J. UWI – Unified Web Interface
- K. VMS – Video Management System

1.04 QUALIFICATIONS

- A. The system programmer shall have attended manufacturer training and obtained technical certification.
- B. The system programmer shall have attended manufacturer training and obtained certification in Genetec Security Center - Enterprise Technical Certification.

- C. The system programmer shall be a certified partner with the following level of qualification:
 - 1. Unified Elite reseller.
 - 2. The system programmer shall submit proof of certifications.

1.05 SUBMITTALS

A. Shop Drawings:

- 1. The Contractor shall provide complete shop drawings which include the following:
 - a. Full schematic wiring information for all devices. Wiring information shall include cable type, cable length, conductor routings, quantities, and point-to-point termination schedules.
 - b. Complete access control system one-line block diagram.
 - c. Statement of the system sequence of operation.
 - d. Riser diagrams showing interconnections.
 - e. Detail drawings showing installation and mounting.
 - f. Fabrication drawings for console arrangements and equipment layout.
 - g. Test and Commission site report
- 2. All drawings shall be fully dimensioned and prepared in DWG format using AutoCAD.

B. Product Data:

- 1. The Contractor shall provide the following:
 - a. Complete product data and technical specification data sheets that includes manufacturer data for all material and equipment, including terminal devices, local processors, computer equipment, and any other equipment provided.

C. As-Built Drawings:

- 1. At the conclusion of the project, the Contractor shall provide as-built drawings. The as-built drawings shall be a continuation of the Contractors shop drawings as modified, augmented, and reviewed during the installation, check out and acceptance phases of the project. All drawings shall be fully dimensioned and prepared in DWG format using AutoCAD.

D. Manuals:

1. At the conclusion of the project, the Contractor shall provide copies of the manuals as described herein. Each manual content shall be identified on the cover. The manual shall include names, addresses, and telephone numbers of each security system integrator installing equipment and systems and the nearest service representatives for each item of equipment for each system. The manuals shall have a table of contents and labeled sections. The manuals shall include all modifications made during installation, checkout, and acceptance. The manuals shall contain the following:

a. Functional Design Manual:

(1) The functional design manual shall identify the operational requirements for the system and explain the theory of operation, design philosophy, and specific functions. A description of hardware and software functions, interfaces, and requirements shall be included for all system operating modes. All operational changes required by customer are to be documented in writing where they differ from original Specification

b. Hardware Manual:

(1) The hardware manual shall describe all equipment furnished including:

- General description and specifications
- Installation and test and commission procedures
- Equipment layout and electrical schematics to the component level
- System layout drawings and schematics
- Alignment and calibration procedures
- Manufacturers repair parts list indicating sources of supply
- Load calculations of equipment operating at maximum load

c. Software Manual:

(1) The software manual shall describe the functions of all software and shall include all other information necessary to enable proper loading, testing, and operation. The manual shall include:

- Definition of terms and functions
- Use of system and applications software

- Initialization, startup, and shut down
- Alarm reports
- Reports generation
- Data base format and data entry requirements
- Directory of all disk files

d. Operators Manual:

(1) The operator manual shall fully explain all procedures and instructions for the operation of the system including:

- Computers and peripherals
- System startup and shut down procedures
- Use of system, command, and applications software
- Recovery and restart procedures
- Graphic alarm presentation
- Use of report generator and generation of reports
- Data entry
- Operator commands
- Alarm messages and reprinting formats
- System access requirements

e. Maintenance Manual

(1) The maintenance manual shall include descriptions of maintenance for all equipment including inspection, periodic preventive maintenance, fault diagnosis, and repair or replacement of defective components. Maintenance manual shall also include a list of recommended spares which are liable to be encountered as part of routine service procedures.

1.06 QUALITY ASSURANCE

A. Manufacturer Qualifications:

1. The manufacturers of all hardware and software components employed shall be established vendors to the access control/security monitoring industry for no less than five (5) years and shall have successfully implemented at least 5 systems of

similar size and complexity.

B. Contractor / Integrator Qualifications:

1. The security system integrator shall have been regularly engaged in the installation and maintenance of integrated access control systems and have a proven track record with similar systems of the same size, scope, and complexity.
2. The security system integrator shall supply information attesting to the fact that their firm is an authorized Enterprise dealer.
3. The security system integrator shall supply information attesting to the fact that their installation and service technicians are competent factory trained and certified personnel capable of maintaining the system and providing reasonable service time.
4. The security system integrator shall provide a minimum of three (3) references whose systems are of similar complexity and have been installed and maintained by the security system integrator in the last five (5) years.
5. There shall be a local representative and factory authorized local service organization that shall carry a complete stock of parts and provide maintenance for these systems.

C. Testing Agencies:

1. The access control hardware shall be tested and listed by Underwriters Laboratories (UL) for UL 294 for Access Control System Units.
2. The hardware shall comply with the following regulatory requirements:
 - a. FCC Part 15 Class A.
 - b. FCC Part 15 Class B.
 - c. FCC Part 68 (TIA968).
 - d. ICES-003.
 - e. CE.
 - f. ECCN for AES 128 bit encryption for IP communication.
 - g. Government standards NISPOM 5-313 Automated Access Control Systems, DICD Annex F 2.3 Accept/Reject Threshold Criteria, JAFAN
 - h. Annex D 2.3 Accept/Reject Threshold Criteria.
 - i. The system shall support Americans with Disabilities Act (ADA) compliance in door and access operation.

1.07 WARRANTY

- A. The Security Management System (SMS) shall be provided with a 5 year limited product warranty from date of registration. Software version updates shall be available for no charge during this warranty. The software media warranty shall be 90 days.

PART 2 - PRODUCTS

2.01 ELECTRONIC ACCESS CONTROL SYSTEM REQUIREMENTS

- A. The ACS shall be an enterprise class IP access control software solution. It shall be fully embedded within a Unified Security Platform (USP). The USP shall allow the seamless unification of the ACS with an IP video management system (VMS).
- B. The ACS shall be highly scalable to support configurations consisting of thousands of doors with facilities spanning multiple geographic areas.
- C. The ACS shall support an unrestricted number of logs and historical transactions (events and alarms) with the maximum allowed being limited by the amount of hard disk space available.
- D. The ACS shall support a variety of access control functionalities, including but not limited to:
 - 1. Controller (Unit) management, door management, elevator management, and area management.
 - 2. Cardholder and cardholder group management, credential management, and access rule management.
 - 3. Badge printing and template creation.
 - 4. Visitor Management.
 - 5. People counting, area presence tracking, and mustering.
 - 6. Offering a framework for third party hardware integration such as biometric, mobile readers, or other devices over IP.
- E. Certification
 - 1. The ACS shall be certified
 - a. UL-294
 - b. ULC-S319
 - c. EN-60839-11-1
 - d. CSPN

- F. The ACS shall support changing passwords of controller units:
 - 1. The ACS shall show the strength of the current unit password.
 - 2. The ACS shall have the ability to change the password manually or using a string password generator for single or multiple units.
 - 3. The ACS shall have the ability to automatically update passwords on schedule.
 - 4. The ACS shall keep the history for passwords and the ability to retrieve them.
 - 5. The ACS shall have the ability to export passwords of units for safekeeping.
- G. The ACS shall support managing certificates of controller units used for secure command and control (HTTPS and RTSPS):
 - 1. Push Initial Certificate
 - 2. Automatically switch from HTTP and RTSP to HTTPS and RTSPS
 - 3. Allow certificate renewal
 - 4. Manage certificates manually for a single device or a batch of devices
 - 5. Automatically update upon configured schedule for single device or batch of devices

2.02 FAILOVER AND STANDBY REQUIREMENTS

- A. Unified Security Platform (USP) shall support native and off-the-shelf failover options.
- B. Failover Directory Native:
 - 1. The Standby Directory shall act as a replacement SSM on hot standby, ready to take over as the acting Directory in case the primary Directory fails. The failover shall occur in less than 1 minute. No action from the user shall be required.
 - 2. The USP shall support up to five (5) Directories on standby, lined up to take over as the acting Directory in a cascading fashion.
 - 3. The Standby Directory shall keep its configuration database synchronized with the primary Directory.
 - 4. The Standby Directory shall support disaster recovery scenarios where a server can be located in another geographic area (or building) and only take over if all other Directories become offline.
 - 5. The Standby Directory shall support synchronization of the configuration databases using a backup and restore mechanism. The synchronization period shall be configurable from 15 minutes to 1 week.
 - 6. The Standby Directory shall support real-time synchronization of the configuration

databases using SQL Mirroring or SQL Always On.

- C. Off-the-shelf standby/failover options (excluding the VMS Archiver) shall include:
 - 1. Native role failover across multiple servers.
 - 2. Windows Clustering.

2.03 ACS ACCESS MANAGEMENT

- A. The ACS shall be based on an open architecture able to support multiple access control hardware manufacturers. The ACS shall be able to integrate with multiple non-proprietary interface modules and controllers, access readers, and other third-party applications.
- B. The ACS shall be an IP enabled solution. All communication between the ACS and hardware controllers shall be based on standard TCP/IP protocol.
- C. Access Manager Role
 - a. The Access Manager Role shall be the server that synchronizes all access control hardware units under its control, such as door controllers and I/O modules. It shall also be able to validate and log all access activities and events when the door controllers and I/O modules are online.
 - b. The Access Manager Role shall maintain the communication link with the hardware controllers under its control. It shall also continuously monitor whether the controllers are online or offline.
 - c. Synchronization of hardware units shall be automated and transparent to users and shall occur in the background. It shall also be possible to manually synchronize units or to synchronize units on a schedule.
 - d. The Access Manager Role shall support doors and controllers located within one or more facilities. The Access Server shall support a minimum of 200 readers and up to 2000 readers per computer.
- D. The Access Server shall store all access events associated with the doors, areas, hardware zones (hardware input points), elevators, and controllers under its direct control.

2.04 ACS GLOBAL CARDHOLDER MANAGEMENT

- A. The ACS shall support global cardholder management and synchronization between a central independent site and remote independent sites, all of which can have their own Directory and databases.
- B. It shall be possible to synchronize the following entities and their configuration data:
 - 1. Cardholders (incl. custom fields)
 - 2. Cardholder groups
 - 3. Credentials

4. Badge templates
- C. Cardholders and other synchronized entities can be added centrally and synchronized to remote sites for central cardholder management.
- D. Cardholders and other synchronized entities can be added at remote sites and synchronized to the central site and other remote sites.
- E. The ACS shall support the assignment of a single card per cardholder across all of an organization's sites.
- F. Manual and scheduled synchronization shall be supported.

2.05 ACS HARDWARE COMPATIBILITY LIST

- A. The ACS shall have an open architecture that supports the integration of third-party IP-based door controllers and I/O modules. The ACS shall simultaneously support mixed configurations of access control hardware from multiple vendors.
- B. The ACS shall support SAM onboard to hold DESfire encryption keys.
- C. The ACS shall support embedded certificate validation engine.
- D. The ACS shall support the use of TLS 1.3 and certificates.
- E. The ACS shall support OSDP Secure Channel.
- F. The ACS shall support OSDP transparent reader mode to read DESfire credentials.
- G. The ACS shall support Manufacturer OSDP command.
- H. The ACS shall support multiple types of hardware devices: single-reader controllers, 2-reader controllers, 1- to 64-reader controllers, integrated readers and door controllers, and Power-over-Ethernet (PoE) enabled door controllers.
- I. The ACS shall support most industry standard card readers that output card data using OSDP and Wiegand protocol, SSCPv2, and Clock-and-Data.
- J. The ACS shall support the following IP-enabled controllers or devices. For a description of their capabilities, refer to the specific controller or device's A&E specifications and design:
 1. Alcatraz Rock
 2. Synergis Master Controller
 3. Synergis Cloud Link
 4. Synergis Cloud Link RoadRunner
 5. Synergis IX

6. HID VertX EVO
7. HID Edge
8. HID Edge EVO
9. Mercury EP controllers
10. Mercury LP controllers
11. Mercury SIO module
12. Mercury M5 Bridge
13. Mercury MS Bridge
14. Assa Abloy Aperio RS485 8 to 1 hub
15. Assa Aperio AH40 (IP) hub
16. Assa Abloy IP Locks (no DSR required)
 - a. Corbin Russwin
 - b. Sargent Passport
 - c. Sargent Profile
 - d. IN120
 - e. IN220
17. Salto Sallis RS485 and PoE routers
18. Salto SVN
19. Schlage AD-300 and AD-400 electronic locks
20. Schlage Control wireless lock
21. Schlage NDE, LE, FE, and BE Networked wireless Mortise lock
22. Axis A1001
23. Axis A1601
24. A1210 power by Genetec
25. A1610 power by Genetec
26. OSDP readers

- a. HID
- b. STid
- c. Cidron
- d. Allegion
- e. Wavelynx
- f. Deister
- g. PHG

K. The following USB enrollment readers shall be supported:

- 1. RF Ideas pcProx HID USB reader for enrolling proximity cards
- 2. RF Ideas AIR ID Enroll iCLASS ID# USB reader for enrolling HID iCLASS cards
- 3. RF Ideas AIR ID Enroll 14443/15693 CSN USB reader for enrolling a MIFARE card using the CSN (card serial number)
- 4. RF Idea AIR ID Enroll pcProx Plus w/iCLASS reader for enrolling proximity and iCLASS cards
- 5. STid STR-W35-E/PH5-5AA
- 6. HID Omnikey 5x2x USB readers

2.06 SEAMLESS UNIFICATION WITH VMS

- A. Through the USP, the ACS shall support integration with an IP Video Surveillance System or MVS. Integration with an IP video surveillance system shall permit the user to view live and recorded video.
- B. Users shall be able to associate one or more video cameras to the following entity types: doors, elevator and hardware zones (input points), and more.
- C. The Monitoring UI shall present a true Unified Security Interface for access control and video surveillance. Advanced live video viewing and playback of archived video shall be available through the Monitoring UI.
- D. It shall be possible to view video associated with access control events when viewing a report.

2.07 ACS CONTROLLER (UNIT) MANAGEMENT

- A. The ACS shall support the discovery, configuration, and management of IP enabled controllers and I/O panels (hardware units). A user shall be permitted to add, delete, or modify a controller if they have the appropriate privileges.
- B. The ACS shall support unit configuration through a preconfigured door template.
- C. The ACS shall support automatic unit discovery. The user shall establish the settings for discovery ports and for the types of unit discovery and the ACS shall automatically detect all connected devices.
- D. The ACS shall support a unit swap utility for swapping out an existing controller with a new controller. The unit swap utility shall avoid the reprogramming of the system whenever a unit is replaced. All logs and events from the old unit shall be maintained.
- E. The ACS shall support pre-configuration of the system prior to the physical hardware installation.
- F. The ACS shall support Firmware upgrade in bulk from the application.
- G. The ACS shall support MIFARE DESfire configuration central management.
- H. The ACS shall centrally manage unit password policy (password strength, rotation, bulk update).

2.08 ACS CARDHOLDER AND CARDHOLDER GROUP MANAGEMENT

- A. The ACS shall support the configuration and management of cardholders and cardholder groups. A user shall be able to add, delete, or modify a cardholder or cardholder group if they have the appropriate privileges.
- B. Custom fields shall be supported for both cardholders and cardholder groups.
- C. The ACS shall permit the following activation/expiration options for a cardholder's profile: delayed activation of a cardholder's profile, expiration based on the date of first use of credentials, or expiration on a user-defined date.
- D. It shall be possible to set a start date and expiration date for the association of a cardholder and an access rule for temporary access.
- E. It shall be possible to associate a picture to a cardholder's profile. The picture shall be imported from a file, captured with a digital camera, or captured from a video surveillance camera. When a cardholder event occurs, the picture of the cardholder shall be displayed in the Monitoring UI. The ACS shall support multiple standard picture formats.
- F. Cardholder groups shall enable the grouping of cardholders to facilitate mass changes to system settings. It shall be possible to assign cardholder groups to access rules, thus avoiding the assignment of one cardholder at a time.

- G. It shall be possible to search by picture association, custom fields, names, and credential codes.
- H. It shall be possible to select multiple cardholders for immediate deactivation or reactivation.
- I. The ACS shall support the synchronization of cardholders and cardholder groups through Active Directory including the credentials and pictures of the cardholders. It shall be possible to import cardholders from Azure AD.
- J. It shall support the ability to track unused credentials for 60 days.
- K. It shall support the import of cardholders, credentials, and custom fields from an external system database or CSV.

2.09 ACS CREDENTIAL MANAGEMENT

- A. The ACS shall support the configuration and management of credentials, for example access cards and keypad PIN numbers. A user shall be able to add, delete, or modify a credential if the user has the appropriate privileges.
- B. The ACS shall support reader transparent mode.
- C. Users shall be able to add Custom Fields (user-defined fields) to credentials. Creating a new credential shall be accomplished either manually or automatically.
- D. Automatic creation shall allow the user to create a credential entity by presenting a credential to a selected reader. The ACS shall read the card data and associate it to the credential entity. It shall be possible to automatically enroll any card format.
- E. The ACS shall support high assurance credentials using validation of a certificate, such as PIV, PIV-I, and CIV.
- F. The ACS shall support multiple credentials per cardholder without necessitating duplicate cardholder information. The ACS shall automatically detect and prevent attempts to register an already-registered credential.
- G. It shall be possible to natively encode DESfire credentials from the user interface using customer's own keys and configuration.
- H. Batch enrollment of credentials shall be supported.
- I. The ACS shall provide a workflow for badge issuance and card requests.
- J. The ACS shall support the use of license plates as a credential.
- K. The ACS shall support duress pin.
- L. The ACS shall natively support the creation and management of mobile IDs in the same way as other credentials.

- M. The ACS shall support the ability to print and enroll credentials.
- N. The ACS shall support the ability to print and encode SEOS and MIFARE credentials.

2.10 ACS DOOR MANAGEMENT

- A. The ACS shall support the configuration and management of doors. A user shall be able to add, delete, or modify a door if they have the appropriate privileges.
- B. The ACS shall permit multiple access rules to be associated to a door.
- C. It shall be possible to unlock all doors from an area at once.
- D. The ACS shall support the following forms of authentication: Mobile app access, Card Only, Card or Keypad (PIN), or Card and Keypad (PIN). It shall be possible to define a schedule for when Card Only or Card and Keypad authentication modes shall be required.
- E. The ACS shall allow the configuration of the relocking mode on doors such as on door open, after a definite time, or on door close.
- F. The ACS shall support the ability to enforce the use of two valid reads from different cardholders to grant access to an area.
- G. The ACS shall support the ability to enable unlocking schedule on a door once an employee has entered the facility.
- H. Readerless doors.
 - 1. The ACS shall support doors configured solely with a lock, a REX, and a door contact but without readers.
 - 2. The implementation of a readerless door shall be possible with the use of standard access hardware IO modules. External hardware, such as timers, shall not be required.
 - 3. Unlocking schedules shall be programmable for readerless doors.
 - 4. Standard door activity reports shall also be possible with readerless doors.
- I. Unlocking schedules and exceptions to unlocking schedules shall be associated with a door. An unlocking schedule shall determine when a door should be automatically unlocked. The ACS shall also support the use of a specific offline unlocking schedule. Exceptions to unlocking schedules shall be used to define time periods during which unlocking schedules shall not be applied, such as during statutory holidays.
- J. The ACS shall support one or more cameras per door. Video shall then be associated to door access events, such as access grant or access denied.

2.11 ACS VISITOR MANAGEMENT

- A. The ACS shall support the configuration and management of visitors. A user shall be able to enroll or remove a visitor if they have the appropriate privileges. The ACS shall support the check-in and check-out of visitors from the Monitoring UI.
- B. A visitor check-in wizard shall facilitate the enrollment process, allowing a user to specify the visitor's specific information.
- C. It shall be possible to set a host leading a group of visitors and a trailing host walking behind visitors, triggering alert if a visitor is not following the delegation.
- D. The ACS shall permit the following credential options during visitor check-in:
 - 1. Use an existing credential.
 - 2. Automatically create a new credential.
 - 3. Manually create a new credential.
- E. The ACS shall support the creation of a pool of visitor credentials in advance. Existing visitor credentials shall be assigned to visitors during the check-in process.
- F. A visitor's profile shall support the real-time modification of visitor information after a visitor has checked in.
- G. The ACS shall also provide comprehensive visitor tracking and visitor reporting. Through the real-time tracking feature, the ACS shall generate a real-time and historical visitor activity listing in the Monitoring UI. The ACS shall also generate visitor-specific reports that provide comprehensive listings of visitors as well as full details on their movement.
- H. It shall be possible to exempt a visitor from any antipassback rules in effect.
- I. The operator shall be able to print visitor badges during the check-in process. The printing of both paper badges (visitor without an assigned credential) and actual credentials shall be supported.
- J. Visitor management and reporting shall be available through the Web interface as well.
- K. It shall be possible to locate a visitor's information or profile by swiping the visitor's credential (card) at a USB reader.
- L. It shall be possible to tag the person visited to the visitor's profile.
- M. It shall be possible to require that the visitor must have an escort to enter an area and that the escort must badge-in to confirm the access of the visitor.
- N. The ACS system shall support third-party visitor management solutions. It shall also be possible to delete visitor historical data after a set interval.

2.12 ACS CUSTOM FIELDS (USER-DEFINED FIELDS)

- A. The ACS shall permit the creation of custom fields. Up to 1,000 custom fields shall be supported.
- B. Custom fields shall be supported for the following entities: cardholders, cardholder groups, credentials, and visitors.
- C. Supported custom fields shall include text, integers, decimal numbers, dates, Boolean, and images (graphics).
- D. Users shall be able to define a default value for a custom field.
- E. The creation of new custom field types shall be possible. New custom field types shall be based on the standard custom fields supported. They shall support user-defined values from which an operator must make a selection.
- F. Administrators have the ability to define which users can view and modify specific custom fields. This shall limit the access to custom field data to users with pre-defined privileges. The ACS shall support querying and report generation using custom fields.
- G. Custom fields can be grouped and ordered within these groups as defined by the user.
- H. Values for custom fields can be imported using the Import Tool.

2.13 ACS IMPORT TOOL

- A. The ACS shall support an integrated Import Tool to facilitate the import of existing credential data. The import of data shall be through the use of the CSV file format. The tool shall be available from the Configuration UI.
- B. It shall be possible to connect to an external Microsoft SQL or Oracle database to import cardholders.
- C. The Import Tool shall also support the ability to manually import data that has been exported from a third-party database if it is in CSV format.
- D. The import tool shall permit the import of the following data:
 - 1. Name, descriptions, picture, email, and status.
 - 2. Group information.
 - 3. Credential name, status, format, and card number (including credentials with custom formats).
 - 4. Partition information.
 - 5. Custom fields.
 - 6. Activation date and expiration date.

- E. Full flexibility in selecting the fields to be imported during an import session shall be available.
- F. The option to use a custom and unique cardholder key shall be specified during the import process to ensure that cardholders with duplicate names will not have their data overwritten. Cardholder key generation shall be automated. The end user shall have the option to select which fields will be used to create this unique key, for example credential number, custom fields, or cardholder name.
- G. The ACS shall also support re-importing a CSV file containing new information to update existing information in the ACS database. Re-importing shall enable bulk amendments to existing access control data.

2.14 GENERAL CLIENT SOFTWARE REQUIREMENTS

- A. The Client Software Applications (CSA) shall provide the user interface for USP configuration and monitoring over any network and be accessible locally or from a remote connection.
- B. The CSA shall consist of the Configuration UI for system configuration and the Monitoring UI for monitoring. The CSA shall be Windows-based and provide an easy-to-use graphical user interface (UI).
- C. The CSA for monitoring shall support running in 64-bit mode.
- D. The Server Administrator shall be used to configure the server database(s). It shall be web-based and accessible locally on the SSM or across the network.
- E. The CSA shall seamlessly merge access control, license plate recognition (ALPR), and video functionalities within the same user application.
- F. The USP shall use the latest user interface (UI) development and programming technologies such as Microsoft WPF (Windows Presentation Foundation), the XAML markup language, and the .NET software framework.
- G. All applications shall provide an authentication mechanism, which verifies the validity of the user. As such, the administrator (who has all rights and privileges) can define specific access rights and privileges for each user in the system.
- H. Logging on to a CSA shall be done either through locally stored USP user accounts and passwords or using the operator's Windows credentials when Active Directory integration is enabled.
- I. When integrated with Microsoft's Active Directory, the CSA and USP shall authenticate users using their Windows credentials. As a result, the USP will benefit from Active Directory password authentication and strong security features.
- J. When integrated with an external identity provider such as Windows Active Directory, ADFS (Active Directory Federation Services) or an Open ID Connect/SAML2 identity provider (ex.: Azure AD), the CSA and USP shall authenticate using a Single-Sign On experience to the users. As a result, the USP will benefit from reusing the same credential throughout enterprise applications.

- K. The CSA shall support multiple languages, including but not limited to the following: English, French, Arabic, Czech, Dutch, German, Hebrew, Hungarian, Italian, Japanese, Korean, Norwegian, Persian (Farsi), Polish, Portuguese (Brazilian), Simplified and Traditional Chinese, Russian, Spanish, Swedish, Thai, Turkish, and Vietnamese.
- L. To enhance usability and operator efficiency, the Configuration UI and Monitoring UI shall support many of the latest UI such as:
1. A customizable Home Page that includes favorite and recently used tasks.
 2. Task-oriented approach for administrator/operator activities where each type of activity (surveillance, visitor management, individual reports, and more) is an operator task.
 3. Consolidated and consistent workflows for video, ALPR, and access control.
 4. Single click functionality for reporting and tracking. The Monitoring UI shall support both single-click reporting for access control, ALPR, and video, as well as single-click tracking of areas, cameras, doors, zones, cardholders, elevators, ALPR entities, and more. Single-click reporting or tracking shall create a new task with the selected entities to report on or track.
- M. Configuration UI and Monitoring UI Home Page and Tasks.
1. The Configuration UI and Monitoring UI shall be task oriented.
 2. A task shall be user interface design patterns whose goal is to simplify the user interface by grouping related features from different systems such as video and access, in the same display window. Features shall be grouped together in a task based on their shared ability to help the user perform a specific task.
 3. Tasks shall be accessible via the Home Page of either the Configuration or the Surveillance CSA.
 4. Newly created tasks shall be accessible via the Configuration UI or the Monitoring UI taskbar.
 5. Similar tasks shall be grouped into the following categories:
 - a. Operation: Access control management, LRP management, and more.
 - b. Investigation: access control activity reports, visitor activity reports, alarm reports, and more.
 - c. Maintenance: Access control, troubleshooters, audit trails, health-related reports, and more.
 6. An operator shall be able to launch a specific task only if they have the appropriate privileges.
 7. The Home Page content shall be customizable through the use of privileges to hide tasks that an operator should not have access to and through a list of favorite and

recently used tasks. In addition, editing a USP XML file to add new tasks on the fly shall also be possible.

8. The configuration of the operator parameters shall be able to be imported and exported for both the Configuration and Monitoring UI.
- N. The Contractor shall provide up to 5 simultaneous Clients, including thick client, Web, and mobile connections.

2.15 CONFIGURATION USER INTERFACE (UI)

A. General

1. The Configuration UI application shall allow the administrator or users with appropriate privileges to change the system configuration. The Configuration UI shall provide decentralized configuration and administration of the USP system from anywhere on the IP network.
 2. The configuration of all embedded ACS, VMS, and ALPR systems shall be accessible via the Configuration UI.
 3. The Configuration UI shall have a home page with single-click access to various tasks.
 4. The Configuration UI shall include a variety of tools such as troubleshooting utilities, import tools, and a unit discover tool, amongst many more.
 5. The Configuration UI shall include a static reporting interface to:
 - a. View historical events based on entity activity. The user shall be able to perform such actions as printing a report and troubleshooting a specific access event from the reporting view.
 - b. View audit trails that show a history of user/administrator changes to an entity.
- B. Common entities such as users, schedules, alarms, and many more, can be reused by all embedded systems (ACS, VMS, and ALPR).

2.16 ACS CLIENT USER INTERFACE (UI)

- A. The Monitoring UI shall fulfill the role of a Unified Security Interface that is able to monitor video, ALPR, and access control events and alarms, as well as view live and recorded video.
- B. The Monitoring UI shall provide a graphical user interface to control and monitor the USP over any IP network. It shall allow administrators and operators with appropriate privileges to monitor their unified security platform, run reports, and manage alarms.
- C. To enhance usability and operator efficiency, the Monitoring UI shall support the following UI concepts:

1. Dynamically adaptive interface that adjusts in real-time to what the operator is doing.
2. Dynamic controls loaded with entity-specific widgets (for example, door and camera widgets).
3. Use of transparent overlays that can display multiple types of data in a seamless fashion.
4. Display tile menus and quick commands.
5. Consolidated and consistent workflows.
6. Tile menus and quick commands easily accessible within every display tile of the user workspace.
7. Single-click functionality for reporting and tracking. The Monitoring UI shall support both single-click reporting for access control, ALPR, and video, as well as single-click tracking of areas, cameras, doors, zones, cardholders, elevators, ALPR entities, and more. Single-click reporting or tracking shall create a new task with the selected entities to report on or to track.

D. Monitoring UI Home Page and Tasks

1. Similar tasks shall be grouped into the following categories:
 - a. Operation: Access control/LRP/video surveillance, visitor management, mustering, access control and video alarm monitoring, and more.
 - b. Investigation: Video bookmark/motion/archive reports, access control activity reports, visitor activity reports, alarm reports, ALPR activity reports, and more.
 - c. Maintenance: Access control and video configuration reports, troubleshooters, audit trails, and more.

E. Dynamically Adaptive UI, Controls section, and Widgets

1. The Monitoring UI shall dynamically adapt to what the operator is doing. This shall be accomplished through the concept of widgets that are grouped in the Monitoring UI Controls section.
2. Widgets shall be mini-applications or mini-groupings in the Monitoring UI Controls section that let the operator perform common tasks and provide them with fast access to information and actions.
3. With a single click on an entity (for example, door or camera) the specific widgets associated to that entity appear and other non-relevant widgets disappear dynamically (instantly). Widgets shall bring the operator information such as door status and camera stream information, as well as user actions, such as door unlock, PTZ controls, and more.

4. Specific widgets include those for a door, camera, alarm, zone, display tile, video stream (statistics), PTZ camera, and more.
- F. Operator Workflows
1. A workflow shall be a sequence of operations an operator or administrator shall execute to complete an activity. The “flow” relates to a clearly defined timeline or sequence for executing the activity.
 2. The Monitoring UI shall be equipped with consistent workflows for the ALPR, video, and access control systems that it unifies.
 3. Generating or printing a report, setting up or acknowledging an alarm, or creating an incident report shall follow the same process (workflow) whether the operator is working with video, ALPR, or access control, or with both video and access control.
- G. Each task within the Monitoring UI shall consist of one or more of the following items:
1. Event list.
 2. Logical tree. Doors, cameras, zones, ALPR units, and elevators shall be grouped under Areas in a hierarchical fashion.
 3. Entities list of all entities being tracked.
 4. Display tiles with various patterns (1 x 1, 2 x 2, and more).
 5. Display tile menu with various commands related to cameras, doors, PTZ, and tile controls.
 6. Control section with widgets.
- H. The Monitoring UI shall support multiple event lists and display tile patterns, including:
1. Event/alarm list layout only
 2. Display tile layout only
 3. Display tile and alarm/event list combination
 4. ALPR map and alarm/event list combination
- I. User workspace customization
1. The user shall have full control over the user workspace through a variety of user-selectable customization options. Administrators shall also be able to limit what users and operators can modify in their workspace through privileges.
 2. Once customized, the user shall be able to save their workspace.
 3. The user workspace shall be accessible by a specific user from any client

application on the network.

4. Display tile patterns shall be customizable.
 5. Event or alarm lists shall span anywhere from a portion of the screen up to the entire screen and shall be resizable by the user. The length of event or alarm lists shall be user-defined. Scroll bars shall enable the user to navigate through lengthy lists of events and alarms.
 6. The Monitoring UI shall support multiple display tile patterns (e.g., 1 display tile (1x1 matrix), 16 tiles (8x8 matrix), and multiple additional variations).
 7. The Monitoring UI shall support as many monitors as the PC video adapters and Windows Operating System are capable of accepting.
 8. Additional customization options include show/hide window panes, show/hide menus/toolbars, show/hide overlaid information on video, resize different window panes, and choice of tile display pattern on a per task basis.
- J. The Monitoring UI shall provide an interface to support the following tasks and activities common to access control, ALPR, and video:
1. Monitoring the events from a live security system (ACS and/or VMS and/or ALPR).
 2. Generating reports, including custom reports.
 3. Monitoring and acknowledging alarms.
 4. Creating and editing incidents and generating incident reports.
 5. Displaying dynamic graphical maps and floor plans, as well as executing actions from dynamic graphical maps and floor plans.
 6. Management and execution of hot actions and macros.
- K. The Monitoring UI shall be able to monitor the activity of the following entities in real-time: areas, ALPR entities, doors, elevators, cameras, cardholders, cardholder groups, zones (input points), and more. The Monitoring UI shall provide an interface to support the following access control tasks and capabilities:
1. Monitoring and management of access events and alarms.
 2. Viewing of cardholder picture or badge IDs.
 3. Verification of cardholder picture IDs against live video.
 4. Visitor management.
 5. People counting or mustering, including resetting the people count in an area.
 6. Door control, including remotely unlocking doors, overriding a door's unlocking

schedules, and enabling door maintenance mode.

7. Forgiving antipassback.
8. Generation of ACS configuration and activity reports.
9. Viewing of HTML files including alarm instructions.

L. Entity Monitoring

1. The USP shall permit the user to select multiple entities to monitor from the Monitoring UI by adding the entities one by one to the tracking list.
2. The Monitoring UI shall provide the option to filter which events shall be displayed in the display tile layout, event list layout, or both.
3. It shall be possible to lock a Monitoring UI display tile so that it only tracks the activity of a specific entity (for example, a specific door or camera).
4. The user shall be able to drag and drop an event from an event list (or an alarm from an alarm list) onto a display tile to view a license plate read, cardholder picture ID, badge ID, or live/archived video, among other options.
5. Event, alarm, monitoring/tracking, and report lists shall contain cardholder pictures where applicable.
6. The user shall be permitted to start or pause the viewing of events within each display tile.

M. Display Tile Packing and Unpacking

1. The Monitoring UI shall support single-click unpacking and packing for, areas, doors, zones, and alarms.
2. The packing and unpacking of entities shall allow operators to quickly obtain additional information and camera views of a specific entity.
3. The unpacking of an entity shall display associated entities. For example, unpacking a door with multiple associated cameras shall display all cameras associated with that door. Unpacking shall reconfigure the display tiles to be able to display all associated entities. For example, unpacking a door (or a zone or alarm) that is currently in a 1 x 1 tile configuration and that has 3 cameras tied to it will create a 1 x 3 display tile arrangement for viewing all associated entities.
4. Packing will return the display to the original tile pattern.

- N. The following additional tools or utilities shall be available from the Monitoring UI: create credentials, create cardholders, and access control troubleshooter.

2.17 SERVER ADMINISTRATOR USER INTERFACE REQUIREMENTS

- A. The Server Administrator shall be used to configure the SSM and the Directory Role (main

configuration) and its database(s), to apply the license, and more.

- B. The Server Administrator shall be a web-based application. Through the Server Administrator, it shall be possible to access the SSM across the network or locally on the server.
- C. Access to the Server Administrator shall be protected via login name, password, and encrypted communications.
- D. The Server Administrator shall allow the administrator (user) to perform the following functions:
 - 1. Manage the system license.
 - 2. Configure the database(s) and database server for the Directory Role.
 - 3. Activate/Deactivate the Directory Role.
 - 4. Manually back up the Directory Role database(s) and/or restore the server database(s), as well as configure scheduled backups of the databases.
 - 5. Define the client-to-server communications security settings.
 - 6. Configure the network communications hardware, including connection addresses and ports.

2.18 UNIFIED WEB INTERFACE (UWI) GENERAL REQUIREMENTS

- A. The USP shall support a unified web interface (UWI) for access control, video, and automatic license plate recognition (ALPR).
- B. The UWI shall be a truly thin client with no download required other than an internet web browser or standard web browser plugins.
- C. The UWI shall be platform independent and run within Microsoft Edge, MS Internet Explorer, Firefox, Safari, and Google Chrome.
- D. The UWI shall be designed as an HTML5 application.
- E. The UWI shall support display on tablet format.
- F. The UWI will support native H.264 video in the web interface.
- G. Web pages for the web interface shall be managed and pushed by the Web Interface Server. Microsoft IIS or any other web hosting service shall not be required given that all the web pages shall be hosted by the Mobile Server.
- H. The Web Interface Server shall provide the ability to define a unique URL to access the web interface, to ensure the security of the application.
- I. The UWI shall provide the ability to load a camera layout.

J. The UWI shall provide the ability to configure, save, and reload private camera layouts.

K. The UWI shall provide the ability to control PTZ cameras.

L. Functionalities:

1. Log in support shall be available using:
 - a. Username and password
 - b. Active Directory
 - c. Azure Active Directory, ADFS, OpenID Connect or SAML2 identity provider
2. Ability for user to change their password.
3. Encrypted communications for all transactions.
4. Print reports and export to CSV file. Unified reports that can be printed, exported to CSV file, and filtered by:
 - a. Alarms
 - b. Bookmarks
 - c. Camera & door events
 - d. ALPR hits & reads
 - e. Incidents
 - f. Time period or specific dates
 - g. Specific area
5. Access Control.
 - a. Cardholder and group (add/modify/delete)
 - b. Credential management (add/modify/delete)
 - c. Access rules management (add/modify/delete)
 - d. Visitor management (check-in/modify/check-out)
 - e. Unlock door
 - f. Override the unlocking schedule on a door
 - g. Door Activities report

6. Alarms.
 - a. Alarm report
7. Threat Level management.
8. Automatic License Plate Recognition (ALPR).
 - a. Live monitoring of the ALPR cameras
 - b. ALPR reads and hits report
 - c. Addition of plate numbers to hotlists
9. Maps.
 - a. Ability to display a geographical map with USP entities geo-located on the map.
 - b. Ability to view any entity configured on the map.
 - c. Ability to search for entities or locations on the map.
 - d. Display locations of Mobile users.
10. Incident management.
 - a. Ability to view active incidents, sort and group them for a customized view.
 - b. Ability to trigger incidents manually.
 - c. Ability to get all details about an incident including related incidents, entities and documents.
 - d. Ability to take ownership of an incident and respond to the defined standard operating procedure geared towards incident resolution.
11. Watchlist to monitor specific entities of interest.

2.19 SMARTPHONE AND TABLET APP GENERAL REQUIREMENTS

- A. The USP shall support mobile apps for various off-the-shelf devices. The mobile apps shall communicate with the USP over any Wi-Fi or cellular network connection.
- B. Mobile apps shall communicate with the USP via a Mobile Server Role (MSR). All communication between the mobile apps and MSR shall be based on standard TCP/IP protocol and shall use the TLS encryption with digital certificates to secure the communication channel.
- C. Supported device manufacturers shall include:

1. Apple devices running iOS 13.0 or later
 2. Android devices 10.0 or later
- D. It shall be possible to download the mobile apps from the Central application store (Apple iTunes App Store, Google Play).
- E. It shall be possible to push configuration to mobile devices through a Mobile Device Management solution such as VMWare Workspace One or Microsoft Intune.
- F. Functionalities
1. Core
 - a. Ability to logon/logoff the UPS using an authorized use profile of the system.
 - b. Ability to support passive authentication from a single sign-on provider (OpenID Connect or SAML2 identity provider).
 - c. Ability to use biometric features (thumbprint, face ID, etc.) to perform connection to the system.
 - d. Ability to change the picture or the password of the user of the mobile app.
 - e. Ability to view the current Threat Level of the system.
 - f. Ability to change the current Threat Level of the system.
 - g. Ability to execute hot actions configured in the user profile.
 - h. Ability to view entities from the USP:
 - (1) Cameras
 - (2) Doors
 - (3) ALPR cameras
 - (4) Web Tile Plugins
 - (5) Layouts
 - (6) Camera Sequences
 - (7) Macros
 - (8) Maps
 - i. Ability to navigate the system hierarchical view of the entities and search entities in the system.

2. Video
 - a. Ability to view live and recorded video from the cameras of the USP. A maximum of eight cameras shall be displayed.
 - b. Ability to view video in native format (H.264).
 - c. Ability to display live and recorded video side-by-side for a specific camera.
 - d. Ability to perform digital zoom on cameras.
 - e. Ability to perform actions on cameras, such as add a bookmark, control a PTZ, control the iris/focus function, save a snapshot, and start/stop recording.
 - f. Ability to view camera layouts.
 - g. Ability to view camera sequences.
 - h. Ability to run a camera events report.
 - i. Ability to change the video quality on the cameras displayed on the mobile app.
 - j. Ability to use the camera of the smartphone and stream a live video feed to a video recorder in the system
3. Access Control
 - a. Ability to view the door state and the door lock state.
 - b. Ability to perform actions on a door such as unlock the door, set the door in maintenance mode, and override the door unlocking schedule.
 - c. Ability to manage cardholders.
4. Automatic License Plate Recognition
 - a. Ability to view live events raised by an ALPR camera.
 - b. Ability to view the read image, context image, and all metadata captured by the ALPR camera.
 - c. Ability to run an ALPR event report.
 - d. Ability to add a license plate to a hotlist on the system.
5. Alarm Management
 - a. Ability to receive push notifications to notify mobile operators that an alarm was received.

- b. Ability to view all active alarms assigned to the mobile operator.
 - c. Ability to perform action on an alarm such as acknowledge, investigate, or alternate-acknowledge an active alarm.
 - d. Ability to view entities attached to the alarm.
6. Map
- a. Ability to display a geographical map with USP entities geo-located on the map.
 - b. Ability to view any entity configured on the map.
 - c. Ability to go to pre-defined map locations using preset buttons.
 - d. Ability to search for entities or locations on the map.
7. Incident management
- a. Ability to view active incidents, sort and group them for a customized view.
 - b. Ability to trigger incidents manually.
 - c. Ability to get all details about an incident including related incidents, entities and documents.
 - d. Ability to take ownership of an incident and respond to the defined standard operating procedure geared towards incident resolution.
- G. It shall be possible to send a message from the client user interface to a mobile operator.
- H. It shall be possible to send a live or playback video sequence from the client UI to a mobile operator.
- I. It shall be possible to view mobile operators who enabled location tracking on a map in the system. The location of the mobile operator should be updated in real time.

2.20 USP THIRD PARTY INTEGRATION

- A. Microsoft Active Directory Integration:
- 1. The USP shall support a direct connection to one or multiple Microsoft Active Directory server via the Active Directory Role(s). Active Directory integration shall enable the synchronization of information from the Active Directory server to the USP.
 - 2. Active Directory integration shall permit the central management of the USP users, user groups, cardholders, and cardholder groups.
 - 3. The USP shall support ADFS for user login.

4. The USP shall be able to connect to and synchronize data from multiple Active Directory servers (up to 10).
5. The USP shall support Azure AD for cardholder synchronization.
6. The USP shall support synchronizing Active Directory Universal Groups as well as security groups belonging to other domains within the same forest.
7. The USP shall support Microsoft Active Directory encryption using LDAP SSL.
8. When enabled, Active Directory shall manage user logon to the USP client applications through the user's Windows credentials. Logging on to the USP shall utilize native Active Directory password management and authentication features.
9. It shall be possible to synchronize the following USP entities and their information from Active Directory with the USP:
 - a. Users (username, first and last names, email address, and more)
 - b. User groups (user group name, description, and group email address)
 - c. Cardholders (first and last names, description, email, picture and more)
 - d. Cardholder groups (cardholder group name, description, and group email address)
 - e. Active Directory attributes to USP custom fields
10. When enabled, the addition, removal, or suspension of a user's Windows account in Active Directory shall result in the creation, deletion, or disabling of the equivalent user account in the USP.
11. When enabled, the addition, removal, or suspension of a user's Windows account in Active Directory shall result in the creation, deletion, or disabling of the equivalent cardholder account in the USP.
12. Supported synchronization methods for additions, modification, and deletions of synchronized entities shall include on first logon (users only), manual synchronization, and scheduled synchronization.
13. The USP shall support user connections across independent organizations by connecting to an external identity provider using claims-based authentication such as ADFS (Active Directory Federation Services), Azure Active Directory, other OpenID Connect & SAML2 providers.

B. Intrusion Detection Integration:

1. The USP shall integrate with third party intrusion panels and devices via an Intrusion SDK. The Intrusion Manager Role shall manage communications with the intrusion panels. Communications with intrusion devices shall be over serial communications and/or an IP network.

2. Integration with intrusion panels shall be possible outside the release cycle of the USP. It shall be possible to add new integrations at any point in time.
3. Functionality available via the integration of intrusion devices with the USP shall include the following (where supported by the intrusion panel):
 - a. Arm and disarm intrusion devices (manually, on schedule, or following a USP event)
 - b. Activate or trigger intrusion device outputs
 - c. View intrusion events and alarms
 - d. Monitor the status, including arming status, of the intrusion devices
 - e. Video verification of intrusion events and alarms with video panels
 - f. Create USP zones using intrusion device inputs
 - g. Alarm panel user management from the USP interface (when supported and available from the alarm panel)
4. Currently supported intrusion panels include:
 - a. Bosch Legacy G Series panels
 - b. Bosch B & G Series panels
 - c. Bosch Map 5000
 - d. DSC Power Series panels
 - e. DMP XR Series panels
 - f. Honeywell Galaxy Dimension and Flex panels
 - g. Vanderbilt SPC
 - h. UTC Advisor Master and Advanced
 - i. Satel INTEGRA panels
 - j. Telenot Complex 400H panels
5. Additional intrusion devices supported include:
 - a. Buytime
 - b. Alarm Panel Receiver
 - c. Southwest Microwave RPMII

C. Third Party Access Control Systems:

1. The USP shall integrate with third-party access control software via the SDK. Communications with access control software shall be over an IP network and should not support administrative tasks such as cardholder management.
2. Integration with access control software shall be possible outside the release cycle of the USP. It shall be possible to add new integrations at any point in time.
3. Functionality available via the integration of access control software with the USP shall include the following (where supported by the access control solution):
 - a. Synchronize access control entities and receive associated events and states within the USP, including:
 - (1) Cardholders
 - (2) Visitors
 - (3) Readers and doors
 - (4) Alarms
 - (5) Inputs and outputs
 - b. Monitor access control events
 - c. Monitor and acknowledge access control alarms
 - d. Trigger actions and outputs in the access control software using hot actions and event-to-actions
 - e. Lock and unlock doors in the access control software
 - f. Video verification of access control events and alarms
 - g. Configure event-to-actions using the access control events and alarms
 - h. Generate Security Center reports using the access control data
 - i. View and monitor states of door entities in the USP maps
4. Currently supported access control manufacturers include:
 - a. Tyco Software CCURE
 - b. UTC Lenel Onguard
 - c. Amag Symmetry
 - d. Siemens Sipass

D. Additional Third-Party Integrations

1. The USP shall support multiple approaches to integrating third party systems. These shall include: Software Development Kits (SDKs), REST-based Web Service SDKs, RTSP Service SDKs, and more.
2. The USP architecture shall support the addition of new connectors to integrate to third party system integration, such as:
 - a. Third party video systems
 - b. Third party access control systems
 - c. ALPR integrations with pay stations, permit vendors, pay-by-phone vendors, and ticketing vendors
 - d. Building management systems
 - e. Access Control ecosystem (such as IDscanner, card synchronization, Guardtour, Morpho Biometrics, Advanced Enrollment)
 - f. Transaction monitoring (POS, Barcode scanning, ATM)
 - g. Industrial IoT: Data ingestion from external devices through standard communication protocols (Modbus, BACnet, OPC, SNMP, HTTP Server, MQTT Client, TCP Server)
 - h. Industrial Protocol Interface: Data exposure from GSC to external protocol interfaces using standard communication protocols (BACnet, SNMP)
 - i. Videowall (Barco, Eizo)
 - j. Human resource management systems (HRMS)
 - k. Intelligent Keys (Salto SVN, Medeco XT, CLIQ, ILOQ (future))
 - l. Gunshot Detection (Shot Spotter, Guardian GunShot)
 - m. Dynamic Logbook: Customizable forms with reporting capabilities

PART 3 - EXECUTION

3.01 WARRANTY

- A. The product shall perform in all material respects in accordance with the accompanying user manual, and the media on which the Software Product resides will be free from defects in materials and workmanship under normal use. Software defects are covered through

Service Releases and Cumulative Updates which are available for a period of 1 year from the date of the software purchase.

- B. Extended warranty, 5 years, shall be included through the purchase of the support service which includes the following additional services over the standard warranty:
 - 1. Access to phone support and online chat for technical assistance
 - 2. Online case management
 - 3. Online system availability monitor
 - 4. Access to Major and Minor Release Upgrades
 - 5. 24/7 pager support and dedicated support specialist

3.02 DEPLOYMENT SERVICES AND SYSTEM COMMISSIONING

A. General Requirements:

- 1. The contractor shall engage the services of the USP vendor to assist in the management of the deployment of the USP at the end-user site on projects that involve:
 - a. Multiple contractors or subcontractors that will be responsible for deploying the USP at multiple client sites in different geographical regions.
 - b. Complex enterprise installations involving advanced functionality (for example The Federation feature, failover, plugins) and/or multiple systems (for example access control, video, ALPR) and/or third-party integrations.
 - c. Extensive use of customized solutions/plugins developed by the vendor that will be integrated into the USP.
- 2. The USP vendor services shall include Deployment Management and System Configuration and Commissioning.

B. Deployment Management Service:

- 1. The Deployment Management service from the vendor shall include a Project Manager acting as the single point of contact for all communications between the contractor and the vendor organization and who will be responsible for:
 - a. Conducting a Risk Assessment of the impact of potential risk factors on the operation of the vendor's USP.
 - b. Providing a project plan for the deployment of the vendor's USP.
 - c. Managing the development and deployment of the custom solution

components that will be integrated into the vendor's USP (if applicable).

- d. Providing a scope of work detailing the services to be provided by the vendor to assist in the deployment of the vendor's USP.
- e. Coordinating and scheduling the vendor field services with the contractor to assist with the deployment of the vendor's USP.
- f. Providing regular project status updates to the contractor regarding the development of custom solutions (if applicable) and the deployment of the vendor's USP.

C. Solution Architect Service:

1. The Solution Architect service from the vendor shall include a Solutions Architect Engineer acting as a single technical point of contact throughout the deployment of the USP, and who will be responsible for:
 - a. Assisting the contractor/subcontractor with the design and architecture of the vendor's USP.
 - b. Conducting technical consultation activities that may include fit/gap analysis, system design reviews, device compatibility assessments, functional and technical design reviews as well as performance reviews of the vendor's USP.
 - c. Conducting a system assessment and ensuring best practices of the vendor's USP are followed.
 - d. Providing upgrade and migration strategy for the vendor's USP where applicable.
 - e. Providing documentation regarding the system architecture, system design, hardware specifications and compatibility requirements, camera bandwidth calculations, and best practices as they relate to the vendor's USP.

D. System Configuration and Commissioning Service:

1. The System Configuration and Commissioning service from the vendor shall include a Field Engineer who will be responsible for:
 - a. Assisting the contractor's or subcontractor's onsite/remote technicians with the configuration and commissioning of the vendor's USP at the client site.
 - b. Conducting a test of the USP following the deployment of the system using real-world operator scenarios to ensure optimal system performance.
 - c. Providing the contractor with a Service Report detailing the tasks completed during the deployment of the USP at the client site, as well as any recommendations for improving the performance of the USP that must

be implemented by the contractor.

- d. Providing a knowledge transfer of the vendor's USP to the contractor following the deployment of the USP at the client site.

3.03 MANUFACTURER END USER OPERATOR TRAINING

- A. The contractor shall engage the services of the USP vendor to assist in the end user training of the USP at the end-user site.

END OF SECTION 28 13 00

SECTION 28 14 13
ACCESS CONTROL DOOR CONTROLLERS

PART 1 - GENERAL

1.01 SYSTEM DESCRIPTION

- A. The specified unit shall be of manufacturer's official product line, designed for commercial and/or industrial 24/7/365 use.
- B. The specified unit shall be based upon standard components and proven technology.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00:
 - 1. Refer to "PART 2 – PRODUCTS" for all Buy America Build America Act (BABA) Requirements.

1.03 SUSTAINABILITY

- A. The specified unit shall be manufactured in accordance with ISO 14001.
- B. The specified unit shall be compliant with the EU directives 2011/65/EU (RoHS) and 2012/19/EU (WEEE).
- C. The specified unit shall be compliant with the EU regulation 1907/2006 (REACH).
- D. The specified unit, including all its components, shall not contain any added PVC.

1.04 ABBREVIATIONS AND ACRONYMS

- A. General abbreviations and acronyms
 - 1. AGC: Automatic gain control
 - 2. ABR: Average Bit Rate
 - 3. AES: Advanced Encryption Standard
 - 4. API: Application Programming Interface
 - 5. Aspect ratio: A ratio of width to height in images
 - 6. Bit Rate: The number of bits/time unit sent over a network
 - 7. Bonjour: Enables automatic discovery of computers, devices, and services on IP networks.
 - 8. DHCP: Dynamic Host Configuration Protocol

9. DNS: Domain Name System
10. EIS: Electronic Image Stabilization
11. FPS: Frames per Second
12. FTP: File Transfer Protocol
13. SFTP: Secure File Transfer Protocol
14. H.264 (Video Compression Format)
15. H.265 (Video Compression Format)
16. HSMS: Hosted Security Management System (SaaS PACS Application)
17. IEEE 802.1x: Authentication framework for network devices
18. IP: Internet Protocol
19. IR light: Infrared light
20. ISO: International Standards Organization
21. JPEG: Joint Photographic Experts Group (image format)
22. LAN: Local Area Network
23. LED: Light Emitting Diode
24. LPR: License Plate Recognition
25. Lux: A standard unit of illumination measurement
26. MBR: Maximum Bit Rate
27. MPEG: Moving Picture Experts Group
28. Multicast: Communication between a single sender and multiple receivers on a network
29. NTP: Network Time Protocol
30. NTSC: National Television System Committee – a color encoding system based on 60Hz
31. ONVIF: Global standard for the interface of IP-based physical security products
32. PACS: Physical Access Control System
33. PAL: Phase Alternating Line – a color encoding system based on 50Hz
34. PoE: Power over Ethernet (IEEE 802.3af/at) standard for providing power over network cable

35. Progressive scan: An image scanning technology which scans the entire picture
36. PTZ: Pan/Tilt/Zoom
37. QoS: Quality of Service
38. RAID: Redundant Array of Independent Disks
39. RMD: Radar Motion Detection
40. RPC: Remote Procedure Call
41. SaaS: Software as a Service
42. SIP: Session Initiation Protocol
43. SMTP: Simple Mail Transfer Protocol
44. SMPTE: Society of Motion Picture and Television Engineers
45. SNMP: Simple Network Management Protocol
46. SSL: Secure Sockets Layer
47. TCP: Transmission Control Protocol
48. TLS: Transport Layer Security
49. Unicast: Communication between a single sender and single receiver on a network
50. UPnP: Universal Plug and Play
51. UPS: Uninterruptible Power Supply
52. VBR: Variable Bit Rate
53. VMS: Video Management System
54. WDR: Wide dynamic range

1.05 CERTIFICATIONS AND STANDARDS

- A. The specified unit shall carry the following EMC approvals:
 1. EN 55032 Class A
 2. EN 50130-4
 3. EN 61000-3-2
 4. EN 61000-3-3
 5. EN 55035

6. EN 61000-6-1
 7. EN 61000-6-2
 8. FCC Part 15 Subpart B Class A
 9. ICES-3(A)/NMB-3(A)
 10. VCCI Class A
 11. RCM AS/NZS CISPR 32 Class A
 12. KS C 9832 Class A
 13. KS C 9835
- B. The specified unit shall meet the following product safety standards:
1. IEC/EN/UL 62368-1 ed. 3
 2. CAN/CSA C22.2 No. 62368-1 ed. 3
 3. UL 294
- C. The specified unit shall meet the following standards
1. Networking:
 - a. IEEE 802.3at (Power over Ethernet Plus)
 - b. IEEE 802.1x (EAP-TLS) (Authentication)
 - c. IPv4 (RFC 791)
 - d. IPv6 (RFC 2460)
 - e. QoS – DiffServ (RFC 2475)
 2. Mechanical Environment:
 - a. EN 50581

1.06 QUALITY ASSURANCE

- A. The contractor or security sub-contractor shall be a licensed security Contractor with a minimum of five (5) years' experience installing and servicing systems of similar scope and complexity and evidence that is completed at least three (3) projects of similar design and is currently engaged in the installation and maintenance of systems herein described.
- B. All installation, configuration, setup, program and related work shall be performed by electronic technicians thoroughly trained by the manufacturer in the installation and service of the equipment provided.
- C. The contractor or designated sub-contractor shall submit credentials of completed

manufacturer certification, verified by a third-party organization, as proof of the knowledge.

D. The specified unit shall be manufactured in accordance with ISO9001.

1.07 WARRANTY

A. The manufacturer shall provide a five (5) year limited hardware warranty for product that is free from defects in design, workmanship and materials under substantiated normal use. Defective products under the warranty period will be either repaired or replaced by the manufacturer.

PART 2 - PRODUCTS

2.01 GENERAL

- A. The product shall be IP-based and comply with established network and video standards.
- B. The product shall be powered by the switch utilizing the network cable. Power injectors (midspans) shall be provided by the contractor when required for proper operation.
- C. The product shall be fully supported by an open and published API (Application Programmers Interface), which shall provide necessary information for integration of functionality into third-party applications.

2.02 NETWORK CONTROL PANEL

A. Network door controller

- 1. The access control network panel shall meet or exceed the following design specifications:
 - a. The network door controller shall be a fully functional stand-alone door network door controller, supporting up to four readers, REX-buttons, auxiliary and external I/Os (break and emergency), door position sensors and door locks.
 - b. The network door controller shall operate on an open source; Linux-based platform, include a built-in web server and be equipped with a standard Ethernet-port for remote access and control.
 - c. The network door controller casing shall be:
 - (1) Designed for DIN rail and wall-mount.
 - (2) Be fitted with tamper detection
 - (3) Equipped with detachable color-coded connectors for reader, I/O door inputs, relay outputs, auxiliary functions and external inputs.
 - d. The network door controller shall support up to 4x OSDP readers or 2x

Wiegand readers. The supported interfaces shall include:

- (1) Wiegand
 - (2) RS485 (OSDP)
 - (3) OSDP Secure Channel
 - (4) OSDP Secure Profile
- e. The network door controller shall support 1-2 wired doors or 1 wired door together with a single wireless lock gateway per controller.
- f. The network door controller shall be plenum-rated.
2. The access control network panel shall meet or exceed the following performance specifications:
- a. Credentials
 - (1) Third-party access management software depending on server capacity. Up to 250,000 credentials stored locally.
 - Utilize both central processing and true distributed processing technology.
 - Local processing stores cardholder data, access groups, time zones, input and output information in network door controller RAM.
 - Distributed processing shall take over the functions of making access decisions, controlling doors, monitoring alarms, activating relays and performing the functions of remote control and time activated actions.
 - b. Door control functionality
 - (1) The network door controller shall support multifactor authentication.
 - (2) The network door controller shall provide a correct response within 1 second of presenting a defined credential.
 - (3) The network door controller shall support individually adjustable shunt times for each door.
 - c. User Interface
 - (1) Web server
 - The network door controller shall contain a built-in web server making hardware configuration available to multiple clients in a standard operating system and browser environment using HTTP, without the need for additional software.

- Optional components downloaded from the network door controller for specific tasks shall be signed by an organization providing digital trust services.
- (2) Language Specification
- The network door controller shall provide a function for altering the language of the user interface and shall include support for at least 10 different languages.
- (3) IP addresses
- The network door controller shall support both fixed IP addresses and dynamically assigned IP addresses provided by a Dynamic Host Control Protocol (DHCP) server.
 - The network door controller shall allow for automatic detection of the Network door controller based on UPnP and Bonjour when using a computer with an operating system supporting this feature.
 - The network door controller shall provide support both for IPv4 and IPv6.
- d. Event functionality
- (1) The network door controller shall hold a history of the last 100,000 events (first in, first out).
- (2) The network door controller shall be equipped with an integrated event functionality, which can be triggered by:
- Tamper detection (Removal of unit cover/tamper front; reader tampering; tilting, vibration)
 - Power loss
 - Network loss
 - Changes in the unit's configuration
 - Door
 - Event logger
 - Hardware
 - Input signal
 - Schedule
 - System
 - Time
 - Virtual inputs through API
- (3) Response to triggers shall include event actions:
- Send notification, using email, HTTP, HTTPS, TCP and

SNMP trap

- External output activation
- Displaying status LED

- (4) Event functions can be configurable via the web interface.
- (5) The network door controller shall be able to respond to triggers from other products on the same network and be able to generate response in other products as a result of a triggered event.

e. Protocol

- (1) The network door controller shall incorporate support for at least IPv4, IPv6, USGv6, ICMPv4/ICMPv6, HTTP, HTTPS, HTTP/2, TLS, QoS Layer 3 DiffServ, SFTP, CIFS/SMB, SMTP, mDNS (Bonjour), UPnP, SNMP v1/v2c/v3 (MIB-II), DNS/DNSv6, DDNS, NTP, NTS, RTSP, RTCP, RTP, SRTP, TCP, UDP, IGMPv1/v2/v3, DHCPv4/v6, ARP, SSH, NTCIP, SIP, LLDP, CDP, MQTT v3.1.1, Syslog, Link-Local address (ZeroConf).
- (2) The SMTP implementation shall include support for SMTP authentication.

f. Time and Date

- (1) To ensure accuracy, the network door controller shall accept external time synchronization from an NTP (Network Time Protocol) server.
- (2) The network door controller shall support the definition of holidays/exception-days in the calendar configured through a third-party software.
- (3) The network door controller shall support time schedules to be defined by a third-party software, only limited in number by the network door controllers' total memory usage.

g. Security

- (1) The network door controller shall support the use of HTTPS and TLS, providing the ability to upload signed certificates to encrypt and secure authentication and communication.
- (2) All communication between network door controller and the access control application shall be done using at least 256-bit AES encryption.
- (3) The network door controller shall support IEEE 802.1X authentication.
- (4) The network door controller shall provide support for restricting access to pre-defined IP addresses only, so-called IP address

filtering.

- (5) The network door controller shall restrict access to the built-in web server by usernames and passwords.

h. System integration

- (1) The network door controller shall be fully supported by an open and published API, which shall provide necessary information for integration of functionality into third-party applications.
- (2) The camera shall conform to ONVIF profile A as defined by the ONVIF Organization.
- (3) The camera shall conform to ONVIF profile C as defined by the ONVIF Organization.

i. Installation and maintenance

- (1) The network door controller shall be supplied with Windows-based management software which allows the assignment of IP addresses, upgrade of firmware of the network door controller.
- (2) The network door controller shall contain a built-in web server making hardware configuration available to multiple clients in a standard operating system and browser environment using HTTP, without the need for additional software.
- (3) The network door controller shall support the use of SNMP-based management tools according to SNMP v1, 2c, 3 / MIB-II.
- (4) The network door controller shall allow updates of the software (firmware) over the network, using FTP or HTTP.
- (5) The network door controller shall accept external time synchronization from an NTP (Network Time Protocol) server.
- (6) The network door controller shall store all customer-specific settings in a non-volatile memory that shall not be lost during power cuts or soft reset.

j. Access log

- (1) The network door controller shall provide an event history of the last 250,000 events, stored locally in the unit. Such transaction history shall be automatically uploaded to the server once communication has been restored.
- (2) The network door controller shall provide a log file, containing information about the 250 latest connections and access attempts since the unit's latest restart. The file shall include information about the connecting IP addresses and the time of connecting.

k. Network door controller diagnostics

- (1) The network door controller shall be equipped with LEDs, capable of providing visible status information. LEDs shall indicate the network door controller's operational status and provide information about communication with receiver, the network status and the network door controller status.
- (2) The network door controller shall be equipped with LED, capable of indicating over-current protection.
- (3) The network door controller shall be monitored by a Watchdog functionality, which shall automatically re-initiate processes or restart the unit if a malfunction is detected.
- (4) The network door controller shall through its web interface and API provide the current status of all inputs and outputs and provide an ability to force-control outputs for test purpose.

l. Hardware interfaces

(1) Door status inputs

- The network door controller shall through color-coded detachable terminals be equipped with four (4) door inputs.
- The network door controller shall through color-coded detachable terminals be equipped with two (2) form C relays for lock control, with the possibility to source with 12 or 24 V from the network door controller or sourcing from external power supply/dry contact.
- The network door controller shall through color-coded detachable terminals be equipped with four (4) configurable inputs/outputs for auxiliary equipment and two (2) configurable input/output for external equipment, supporting max 30 V DC.

(2) Readers

- The network door controller shall through color-coded detachable terminal blocks be able to support two wired readers, communicating either using a Wiegand interface, or an OSDP interface over RS-485 half-duplex.

(3) Inputs/Outputs

- The network door controller shall through detachable terminal blocks provide:
 - i. Six ports that can either be configured as digital (alarm) inputs or digital outputs, supporting max 30 V DC. When used as input, it should be configured to respond to normally open (NO) or normally closed (NC)

dry contacts.

- ii. All alarm points shall be individually annunciated upon any change of state. Alarm contacts shall not be connected in parallel or series in zones, unless specifically shown on the contract drawings or stated herein. Double doors with alarm contacts on each leaf of the double door unit may be wired in series, for that double door unit.

(4) Network interface

- The network door controller shall be equipped with one 10BASE-T/100BASE-TX Ethernet-port using a RJ45 connector and shall support auto negotiation of network speed and transfer mode (full and half duplex).

m. Power

(1) The network door controller shall have the following power requirements

- 10,5–28 V DC, max 36 W
- Power over Ethernet (PoE) IEEE 802.3at Type 2 Class 4
- 12 V DC as backup

(2) The network door controller shall be able to provide the following power to doors and accessories

- 2x relay NO/NC, max 2 A DC for accessories and relays
- 2x 12/24 V DC, max 24 W for door lock

(3) The network door controller shall, when operating on DC-power, be able to provide 1800 mA at 12 V to connected devices.

(4) The network door controller shall, when operating via PoE Class 4, be able to provide 900 mA at 12 V to connected devices.

(5) The network door controller shall be able to rely on a separate battery power input without manual intervention when the primary power source fails.

n. Environmental

(1) Operate in a temperature range of -40° C to 55° C (-40° F to 131° F).

(2) Operate in a humidity range of 20–85% RH (non-condensing).

3.01 INSTALLATION

- A. The contractor's or subcontractor's main resources within the project shall carry proper professional certification issued by the manufacturer and verified by a third-party organization to confirm sufficient product and technology knowledge.
- B. The contractor shall carefully follow instructions in documentation provided by the manufacturer to ensure all steps have been taken to provide a reliable, easy-to-operate system.
- C. All equipment shall be tested and configured in accordance with instructions provided by the manufacturer prior to installation.
- D. Software found in products shall be the latest and most up-to-date version as specified by the manufacturer, or by the product component provider.
- E. All equipment requiring users to log on using a password shall be configured with user/site-specific password/passwords. No system/product default passwords shall be allowed.
- F. A proper installation shall meet NEC (National Electrical Code – US only) per the guidelines of that year's revision. When properly installed equipment meets Low Voltage, Class 2 classification of the NEC.

END OF SECTION 28 14 13

SECTION 28 15 00
ACCESS CONTROL HARDWARE DEVICES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Section 28 13 00 “Access Control and Security Management Software” for control and monitoring applications.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00:
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) Requirements.

1.03 SYSTEM DESCRIPTION

- A. Section includes an autonomous access control device incorporating multi-factor biometric facial authentication, tailgating and video analytics.
- B. Product - An IP enabled access control peripheral capable of face authentication, tailgate detection, advanced video analytics to be used as a component of an expanded existing or new access control system.

1.04 CERTIFICATIONS AND STANDARDS

- A. Standards
 - 1. IEEE 802.3 Ethernet Standards
 - 2. FCC Code of Federal Regulations, Title 47, Part 15, Class B
 - 3. UL 294 Access Control Systems Units
 - 4. ONVIF Profile S
 - 5. ONVIF Profile T
- B. General abbreviations and acronyms
 - 1. DHCP: Dynamic Host Configuration Protocol
 - 2. IEEE 802.1x: Authentication framework for network devices
 - 3. IP: Internet Protocol

4. LAN: Local Area Network
5. NTP: Network Time Protocol
6. ONVIF: Global standard for the interface of IP-based physical security products
7. PoE: Power over Ethernet (IEEE 802.3af/at) standard for providing power over network cable
8. SaaS: Software as a Service
9. SIP: Session Initiation Protocol
10. SMTP: Simple Mail Transfer Protocol
11. 1FA – Single Factor Authentication (Face or Badge)
12. 1FAF – Single Factor Authentication (Face Only)
13. 2FA- Two Factor Authentication (Face and Badge)
14. 3FA- Three Factor Authentication (Face and Badge + PIN)
15. 2FAM – Two Factor Authentication (Mask and Badge)

1.05 SUBMITTALS

- A. Informational Submittals
 1. Product Data – Manufacturer’s printed or electronic data sheets
 2. Manufacturer's instructions
- B. Closeout Submittals
 1. Warranty documentation
 2. Manufacturer's installation, configuration and operation manuals
 3. As-built wiring diagrams

1.06 QUALIFICATIONS

- A. Manufacturer shall be ISO 9001 certified with a minimum of five years’ experience in producing access control equipment.
- B. Installers shall be trained by the Manufacturer to install, configure and commission the access control system.

1.07 QUALITY ASSURANCE

- A. The contractor or security sub-contractor shall be a licensed security Contractor with a

minimum of five (5) years' experience installing and servicing systems of similar scope and complexity and evidence that is completed at least three (3) projects of similar design and is currently engaged in the installation and maintenance of systems herein described.

- B. All installation, configuration, setup, program and related work shall be performed by electronic technicians thoroughly trained by the manufacturer in the installation and service of the equipment provided.
- C. The contractor or designated sub-contractor shall submit credentials of completed manufacturer certification, verified by a third-party organization, as proof of the knowledge.

1.08 WARRANTY

- A. The manufacturer shall provide a five (5) year limited hardware warranty for product that is free from defects in design, workmanship and materials under substantiated normal use. Defective products under the warranty period will be either repaired or replaced by the manufacturer.

PART 2 - PRODUCTS

2.01 GENERAL

- A. Units shall be IP-based and comply with established network and video standards.
- B. The autonomous access control device shall be an IP-enabled device with both Wiegand and OSDP interfaces capable of face authentication, multi-factor authentication, tailgate detection/alerting, mask detection/alerting and providing an ONVIF compliant video stream.
- C. The autonomous access control device shall be capable of sending alarms and alerts for access control events, tailgating events and mask detection events to the access control system using either Wiegand or OSDP without the need for a software or database integration.
- D. The autonomous access control device shall support the configuration of multiple authentication modes (1FA, 1FAF, 2FA, 2FAM)
- E. The autonomous access control device shall be capable of detecting, classifying and sending alerts for multiple security scenarios:
 - 1. Tailgating: An unauthenticated person follows an authenticated person into an area.
 - 2. Crossing: An unauthenticated person enters an area at the same time as a person is leaving an area.
 - 3. Unauthorized Entry: An authenticated person enters an area without another person present
 - 4. 2FA Mismatch: A person presents a credential during a 2FA transaction that does

not match the credential stored with the person's profile.

- F. The autonomous access control device shall allow for inputs and output to support independent protocols simultaneously.
 - 1. ACS Input = Wiegand OR OSDP (Secure Channel)
 - 2. ACS Output = Wiegand OR OSDP (Secure Chanel)
- G. The autonomous access control device shall support an automatic enrollment mode by leveraging artificial intelligence based on inputs and outputs from the ACS. A user's enrollment shall be completed without requiring any manual intervention by a system administrator.
- H. The autonomous access control device shall support a manual enrollment mode that shall be managed by a system administrator.
- I. The autonomous access control device shall provide instruction and feedback to the user using both the OLED display as well as LEDs located on the device.
 - 1. The OLED display shall be language agnostic by providing graphics and animations to provide prompts and feedback to the user.
- J. The autonomous access control device shall allow for configuration and management using a web-based administration application.
 - 1. The web-based administration application shall support both on-premise instances as well as vendor-provided cloud-based instances.
 - 2. The web-based administration application shall support installation on both Windows operating systems and Linux operating systems.
 - 3. The web-based administration application shall support event reporting including still images representing access control events, tailgate events, enrollment events and mask detection events.
 - 4. The web-based administration application shall support event data visualization and analytics.
- K. The autonomous access control device may be networked with other autonomous access control devices and managed by a single software platform
 - 1. Profile synchronization
 - 2. Event / alert upload and storage
 - 3. Firmware update
 - 4. Profile Back-Up and Restore
 - 5. Device time synchronization

- L. The autonomous access control device shall allow for configuration and management using a REST based API.
- M. The REST based API shall support token-based authentication.
- N. The REST based API shall support webhooks.
- O. The REST based API shall support OpenAPI Specification (OAS-v3)
- P. The autonomous access control device shall allow for configuration using a QR code that can be presented to the device during installation

2.02 FEATURES/CAPABILITIES

- A. Face authentication technology with liveness detection
- B. Tailgate detection technology
- C. Mask detection technology
- D. OLED display
- E. Wiegand / OSDP Input
- F. Wiegand / OSDP Output
- G. ONVIF certified for Profile S and Profile T

2.03 SPECIFICATION

- A. Biometrics
 - 1. Per Device – 10,000 profiles
 - 2. Per Account – unlimited profiles
 - 3. Match Speed – 2 seconds
 - 4. Throughput – 30 people per minute
- B. Connectivity
 - 1. Access Control Input – Wiegand, OSDP (Secure Channel)
 - 2. Access Control Output -Wiegand, OSDP (Secure Channel)
- C. Card Formats
 - 1. Predefined – 26-Bit, 34-Bit, 35-Bit, 37-Bit
 - 2. Custom – Up to 254 bits

PART 3 - EXECUTION

3.01 INSTALLATION

- A. The contractor's or subcontractor's main resources within the project shall carry proper professional certification issued by the manufacturer and verified by a third-party organization to confirm sufficient product and technology knowledge.
- B. The contractor shall carefully follow instructions in documentation provided by the manufacturer to ensure all steps have been taken to provide a reliable, easy-to-operate system.
- C. All equipment shall be tested and configured in accordance with instructions provided by the manufacturer prior to installation.
- D. All firmware found in products shall be the latest and most up-to-date version as specified by the manufacturer, or by the product component provider.
- E. All equipment requiring users to log on using a password shall be configured with user/site-specific password/passwords. No system/product default passwords shall be allowed.
- F. All wires shall be run through conduit to prevent failure caused by rodent damage.
- G. Connections between card readers and a door controller shall not exceed 100 meters.
- H. All peripheral devices shall be grounded.
- I. Contractor shall avoid locating the reader/controller in a location subject to direct sunlight, dust or soot.
- J. Contractor shall install a 2-gang box prior to device mounting and termination
- K. Box shall be located on the centerline of the associated badge reader if applicable.
- L. Box shall be located at 60 inches (5 feet) above finished floor (AFF- as measured to the bottom of the box).
- M. IP addressing shall be coordinated with the Owner's responsible IT personnel.
- N. Contractor shall install a 2-gang switch box prior to device mounting and termination. Box must be mounted at 5 feet high from the bottom of the box and above existing card reader (or alone if no reader is being used) requires this to be clean and clear.
- O. All network connections to the reader/controller shall be tested for proper levels of performance.

END OF SECTION 28 15 00

SECTION 28 20 00
VIDEO SURVEILLANCE

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00:
 - 1. Refer to "PART 2 – PRODUCTS" for all Buy America Build America Act (BABA) Requirements.

1.03 SUMMARY

- A. Section includes a video surveillance system consisting of cameras, digital video recorder, data transmission wiring, and a control station with its associated equipment.
- B. Related Requirements:
 - 1. Section 28 13 00 - Access Control System Software and Database Management to integrate access control system interface and control.

1.04 DEFINITIONS

- A. AGC: Automatic gain control.
- B. BNC: Bayonet Neill-Concelman - type of connector.
- C. B/W: Black and white.
- D. CCD: Charge-coupled device.
- E. FTP: File transfer protocol.
- F. IP: Internet protocol.
- G. LAN: Local area network.
- H. MPEG: Moving picture experts group.
- I. NTSC: National Television System Committee.
- J. PC: Personal computer.
- K. PTZ: Pan-tilt-zoom.
- L. RAID: Redundant array of independent disks.

- M. TCP: Transmission control protocol - connects hosts on the Internet.
- N. UPS: Uninterruptible power supply.
- O. WAN: Wide area network.

1.05 SUBMITTALS

- A. Product Data: For each type of product indicated. Include dimensions and data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For video surveillance. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Functional Block Diagram: Show single-line interconnections between components for signal transmission and control. Show cable types and sizes.
 - 3. Dimensioned plan and elevations of equipment racks, control panels, and consoles. Show access and workspace requirements.
 - 4. Wiring Diagrams: For power, signal, and control wiring.
- C. Design Data: Include an equipment list consisting of every piece of equipment by model number, manufacturer, serial number, location, and date of original installation. Add pretesting record of each piece of equipment, listing name of person testing, date of test, set points of adjustments, name and description of the view of preset positions, description of alarms, and description of unit output responses to an alarm.
- D. Operation and Maintenance Data: For cameras, power supplies, infrared illuminators, monitors, videotape recorders, digital video recorders, video switches, and control-station components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 01 78 23 - Operation and Maintenance Data, include the following:
 - 1. Lists of spare parts and replacement components recommended to be stored at the site for ready access.

1.06 PROJECT CONDITIONS

- A. Environmental Conditions: Capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:
 - 1. Control Station: Rated for continuous operation in ambient temperatures of 60 to 85 deg F and a relative humidity of 20 to 80 percent, noncondensing.
 - 2. Interior, Controlled Environment: System components, except central-station control unit, installed in temperature-controlled interior environments shall be rated for continuous operation in ambient temperatures of 36 to 122 deg F dry bulb

and 20 to 90 percent relative humidity, noncondensing. Use NEMA 250, Type 1 enclosures.

3. Interior, Uncontrolled Environment: System components installed in non-temperature-controlled interior environments shall be rated for continuous operation in ambient temperatures of 0 to 122 dry bulb and 20 to 90 percent relative humidity, noncondensing. Use NEMA 250, Type 3 enclosures.
4. Exterior Environment: System components installed in locations exposed to weather shall be rated for continuous operation in ambient temperatures of [minus 30 to plus 122 deg F dry bulb and 20 to 90 percent relative humidity, condensing. Rate for continuous operation when exposed to rain as specified in NEMA 250, winds up to 85 mph Use NEMA 250, Type 4X enclosures.
5. Hazardous Environment: System components located in areas where fire or explosion hazards may exist because of flammable gases or vapors, flammable liquids, combustible dust, or ignitable fibers shall be rated, listed, and installed according to NFPA 70.
6. Corrosive Environment: System components subject to corrosive fumes, vapors, and wind-driven salt spray in coastal zones. Use NEMA 250, Type 4X enclosures.
7. Security Environment: Camera housing for use in high-risk areas where surveillance equipment may be subject to physical violence.

1.07 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of cameras, equipment related to camera operation, and control-station equipment that fail in materials or workmanship within specified warranty period.
 1. Warranty Period: Three years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 SYSTEM REQUIREMENTS

- A. Video-signal format shall comply with NTSC standard, ip video.
- B. Surge Protection: Protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads. Include surge protection for external wiring of each conductor's entry connection to components.
 1. Minimum Protection for Power Connections 120 V and More: Auxiliary panel suppressors complying with requirements in Section 26 43 13 - Surge Protection for Low-Voltage Electrical Power Circuits.
 2. Minimum Protection for Communication, Signal, Control, and Low-Voltage Power Connections: Comply with requirements in Section 26 43 13 - Surge Protection for Low-Voltage Electrical Power Circuits as recommended by

manufacturer for type of line being protected.

2.02 PERFORMANCE REQUIREMENTS

- A. 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.
- B. Comply with NECA 1.
- C. Comply with NFPA 70.
- D. Electronic data exchange between video surveillance system with an access-control system shall comply with SIA TVAC.

2.03 IP VIDEO SYSTEMS

- A. Manufactures:
 - 1. Camera Basis of Design, Alarm.com commercial Pro Series.
 - 2. Refer to camera schedule on plans for models, hardware, and accessories.
- B. Description:
 - 1. System shall provide high-quality delivery and processing of IP-based video and control data using standard Ethernet-based networks.
 - 2. System shall have seamless integration of all video surveillance and control functions.
 - 3. Graphical user interface software shall manage all IP-based video matrix switching and camera control functions, alarm monitoring and control, and recording and archive/retrieval management. IP system shall also be capable of integrating into larger system environments.
 - 4. System design shall include all necessary compression software for high-performance, dual stream. Unit shall provide connections for all video cameras
 - 5. All camera signals shall be compressed, encoded, and delivered onto the network for processing and control by the IP video-management software.
 - 6. Camera system units shall be ruggedly built and designed for extreme adverse environments, complying with NEMA Type environmental standards.
 - 7. Encoder/decoder combinations shall place video and data network stream that can be managed from multiple workstations on the user's LAN or WAN.
 - 8. All system interconnect cables, workstation PCs, and network intermediate devices shall be provided for full performance of specified system.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine pathway elements intended for cables. Check raceways and other elements for compliance with space allocations, installation tolerance, hazards to camera installation, and other conditions affecting installation.
- B. Examine roughing-in for LAN, WAN, and IP network before device installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 WIRING

- A. Comply with requirements in Section 27 05 28 - Pathways for Communications Systems.
- B. Wiring Method: Install cables in raceways unless otherwise indicated.
 - 1. Except raceways are not required in accessible indoor ceiling spaces and attics.
 - 2. Except raceways are not required in hollow gypsum board partitions.
 - 3. Conceal raceways and wiring except in unfinished spaces.
- C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.
- D. Splices, Taps, and Terminations: For power and control wiring, use numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures. 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.
- E. For communication wiring, comply with the following:
 - 1. Section 27 15 13 - Communications Copper Horizontal Cabling.
- F. Grounding: Provide independent-signal circuit grounding recommended in writing by manufacturer.

3.03 VIDEO SURVEILLANCE SYSTEM INSTALLATION

- A. Install cameras and infrared illuminators level and plumb.
- B. Set pan unit and pan-and-tilt unit stops to suit final camera position and to obtain the field of view required for camera. Connect all controls and alarms and adjust.
- C. Install latest firmware updates to cameras and IP-based devices.
- D. Install latest version release, patches, and updates to server and managing software.
- E. Pre-configure cameras with owner provided IP addresses.

- F. Enable QoS on cameras per owner's IT representative's requirements.

3.04 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- C. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- D. Tests and Inspections:
 - 1. Inspection: Verify that units and controls are properly installed, connected, and labeled, and that interconnecting wires and terminals are identified.
 - 2. Pretesting: Align and adjust system and pretest components, wiring, and functions to verify that they comply with specified requirements. Conduct tests at varying lighting levels, including day and night scenes as applicable. Prepare video-surveillance equipment for acceptance and operational testing as follows:
 - a. Verify operation of auto-iris lenses.
 - b. Set back-focus of fixed focal length lenses. At focus set to infinity, simulate nighttime lighting conditions by using a dark glass filter of a density that produces a clear image. Adjust until image is in focus with and without the filter.
 - c. Set back-focus of zoom lenses. At focus set to infinity, simulate nighttime lighting conditions by using a dark glass filter of a density that produces a clear image. Additionally, set zoom to full wide angle and aim camera at an object 50 to 75 feet away. Adjust until image is in focus from full wide angle to full telephoto, with the filter in place.
 - d. Set and name all preset positions; consult Owner's personnel.
 - e. Set sensitivity of motion detection.
 - f. Connect and verify responses to alarms.
 - g. Verify operation of control-station equipment.
 - 3. Test Schedule: Schedule tests after pretesting has been successfully completed and system has been in normal functional operation for at least 14 days. Provide a minimum of 10 days' notice of test schedule.

4. Operational Tests: Perform operational system tests to verify that system complies with Specifications. Include all modes of system operation. Test equipment for proper operation in all functional modes.
- E. Video surveillance system will be considered defective if it does not pass tests and inspections.
- F. Prepare test and inspection reports.

3.05 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose. Tasks shall include, but are not limited to, the following:
 1. Check cable connections.
 2. Check proper operation of cameras and lenses. Verify operation of auto-iris lenses and adjust back-focus as needed.
 3. Adjust all preset positions; consult Owner's personnel.
 4. Recommend changes to cameras, lenses, and associated equipment to improve Owner's use of video surveillance system.
 5. Provide a written report of adjustments and recommendations.

3.06 CLEANING

- A. Clean installed items using methods and materials recommended in writing by manufacturer.
- B. Clean video-surveillance-system components, including camera-housing windows, lenses, and monitor screens.

3.07 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain video-surveillance equipment.

END OF SECTION

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SECTION 28 21 13
IP CAMERAS

PART 1 - GENERAL

1.01 SYSTEM DESCRIPTION

A. General Requirements

1. The specified unit shall be of manufacturer's official product line, designed for commercial and/or industrial 24/7/365 use.
2. The specified unit shall be based upon standard components and proven technology using open and published protocols.

B. Sustainability

1. The specified unit shall be manufactured in accordance with ISO 14001.
2. The specified unit shall be compliant with the EU directives 2011/65/EU (RoHS) and 2012/19/EU (WEEE).
3. The specified unit shall be compliant with the EU regulation 1907/2006 (REACH).
4. The specified unit, including all its components, shall not contain any added PVC.
5. The manufacturer shall have signed and support the UN Global Compact initiative as defined by United Nations.

1.02 RELATED WORK

A. SUMMARY OF WORK: Section 01 11 00:

1. Refer to "PART 2 – PRODUCTS" for all Buy America Build America Act (BABA) Requirements.

1.03 CERTIFICATIONS AND STANDARDS

A. General abbreviations and acronyms

1. AGC: Automatic gain control
2. ABR: Average Bit Rate
3. AES: Advanced Encryption Standard
4. API: Application Programming Interface
5. Aspect ratio: A ratio of width to height in images

6. Bit Rate: The number of bits/time unit sent over a network
7. Bonjour: Enables automatic discovery of computers, devices, and services on IP networks.
8. DHCP: Dynamic Host Configuration Protocol
 - (1) DNS: Domain Name System
9. EIS: Electronic Image Stabilization
10. FPS: Frames per Second
11. FTP: File Transfer Protocol
12. SFTP: Secure File Transfer Protocol
13. H.264 (Video Compression Format)
14. H.265 (Video Compression Format)
15. HSMS: Hosted Security Management System (SaaS PACS Application)
16. IEEE 802.1x: Authentication framework for network devices
17. IP: Internet Protocol
18. IR light: Infrared light
19. ISO: International Standards Organization
20. JPEG: Joint Photographic Experts Group (image format)
21. LAN: Local Area Network
22. LED: Light Emitting Diode
23. LPR: License Plate Recognition
24. Lux: A standard unit of illumination measurement
25. MBR: Maximum Bit Rate
26. MPEG: Moving Picture Experts Group
27. Multicast: Communication between a single sender and multiple receivers on a network
28. NTP: Network Time Protocol
29. NTSC: National Television System Committee – a color encoding system based on 60Hz

30. ONVIF: Global standard for the interface of IP-based physical security products
31. PACS: Physical Access Control System
32. PAL: Phase Alternating Line – a color encoding system based on 50Hz
33. PoE: Power over Ethernet (IEEE 802.3af/at) standard for providing power over network cable
34. Progressive scan: An image scanning technology which scans the entire picture
35. PTZ: Pan/Tilt/Zoom
36. QoS: Quality of Service
37. RAID: Redundant Array of Independent Disks
38. RMD: Radar Motion Detection
39. RPC: Remote Procedure Call
40. SaaS: Software as a Service
41. SIP: Session Initiation Protocol
42. SMTP: Simple Mail Transfer Protocol
43. SMPTE: Society of Motion Picture and Television Engineers
44. SNMP: Simple Network Management Protocol
45. SSL: Secure Sockets Layer
46. TCP: Transmission Control Protocol
47. TLS: Transport Layer Security
48. Unicast: Communication between a single sender and single receiver on a network
49. UPnP: Universal Plug and Play
50. UPS: Uninterruptible Power Supply
51. VBR: Variable Bit Rate
52. VMS: Video Management System
53. WDR: Wide dynamic range

B. The specified unit shall carry the following EMC approvals:

1. EAC

2. EN 55032 Class A
3. EN 55035
4. IEC 62236-4
5. EN 61000-3-2
6. EN 61000-3-3
7. EN 61000-6-1
8. EN 61000-6-2
9. FCC Part 15 Subpart B Class A
10. ICES-3(A)/NMB-3(A)
11. VCCI Class A
12. RCM AS/NZS CISPR 32 Class A
13. KC KN32 Class A, KN35

C. The specified unit shall meet the following product safety standards:

1. IEC/EN/UL 62368-1
2. CAN/CSA C22.2 No. 62368-1
3. IEC/EN/UL 60950-22
4. CAN/CSA-C22.2 No. 60950-22
5. IS 13252

D. The specified unit shall meet relevant parts of the following video standards:

1. SMPTE 296M (HDTV 720p)
2. SMPTE 274M (HDTV 1080p)

E. The specified unit shall meet the following standards

1. MPEG-4:
 - a. ISO/IEC 14496-10 Advanced Video Coding (H.264)
 - b. ISO/IEC 23008-5 Advanced Video Coding (H.265)
2. Network:

- a. IEEE 802.3at (Power over Ethernet Plus)
 - b. IEEE 802.1x (EAP-TLS, PEAP-MSCHAPv2) (Authentication)
 - c. IPv4 (RFC 791)
 - d. IPv6 (RFC 2460)
 - e. QoS – DiffServ (RFC 2475)
 - f. NIST SP500-267
3. Cybersecurity
- a. ETSI EN 303 645
4. Mechanical environment:
- a. IEC 60068-2-1
 - b. IEC 60068-2-2
 - c. IEC 60068-2-6
 - d. IEC 60068-2-14
 - e. IEC 60068-2-27
 - f. IEC 60068-2-78
 - g. IEC/EN 60529 IP66
 - h. IEC/EN 62262 IK10
 - i. NEMA 250 Type 4X
 - j. NEMA TS 2 (2.2.7-2.2.9)

1.04 QUALITY ASSURANCE

- A. The contractor or security sub-contractor shall be a licensed security Contractor with a minimum of five (5) years' experience installing and servicing systems of similar scope and complexity and evidence that is completed at least three (3) projects of similar design and is currently engaged in the installation and maintenance of systems herein described.
- B. All installation, configuration, setup, program and related work shall be performed by electronic technicians thoroughly trained by the manufacturer in the installation and service of the equipment provided.
- C. The contractor or designated sub-contractor shall submit credentials of completed manufacturer certification, verified by a third-party organization, as proof of the knowledge.

D. The specified unit shall be manufactured in accordance with ISO9001.

1.05 WARRANTY

A. The manufacturer shall provide a five (5) year limited hardware warranty for product that is free from defects in design, workmanship and materials under substantiated normal use. Defective products under the warranty period will be either repaired or replaced by the manufacturer.

PART 2 - PRODUCTS

2.01 GENERAL

- A. The product shall be IP-based and comply with established network and video standards.
- B. The product shall be powered by the switch utilizing the network cable. Power injectors (midspans) shall be provided by the contractor when required for proper operation.
- C. The product shall be fully supported by an open and published API (Application Programmers Interface), which shall provide necessary information for integration of functionality into third-party applications.

2.02 VIDEO SURVEILLANCE SCHEDULE

- A. The product or product types listed below describing various resolutions, form-factor and features shall be supplied by a single manufacturer for video surveillance system.
- B. The products will be as follows:
 - 1. 360° network camera with four 5 MP sensor.
 - 2. Outdoor-ready PTZ with HDTV 1080p and 40x optical zoom.
 - 3. Dual-sensor panoramic camera.
 - 4. 4x 4K multidirectional network camera
 - 5. 7 MP panoramic camera with 180° coverage
 - 6. Fixed 5MP network dome camera with deep learning

2.03 VIDEO SURVEILLANCE CAMERAS

- A. 360° network camera with four 5 MP sensor
 - 1. The specified product shall meet or exceed the following design specifications:
 - a. The camera shall operate on an open source and Linux-based platform and include a built-in web server.
 - b. The camera shall incorporate four, individually positioned 5MP sensors.

- c. The camera shall be equipped with a 2.8 mm lens with fixed iris and autofocus, providing 360° horizontal field of view and an 84° vertical field of view.
 - d. The camera shall support exchangeable lenses up to a maximum of 16 mm.
 - e. The camera shall be equipped with a motorized 30x optical zoom lens with DC-iris | P-Iris,
 - f. The camera shall be manufactured with a metal (aluminum) casing.
 - g. The camera shall be designed to be compatible with the manufacturer's supported Q60 models, allowing to use the same power supply and mounting solution.
 - h. The camera shall provide local video storage utilizing a SD/SDHC/SDXC memory card expansion.
 - i. The camera shall be manufactured with an IP66-, NEMA 4X- and IK10-rated casing and a polycarbonate dome.
2. The specified product shall meet or exceed the following performance specifications:
- a. Illumination
 - (1) The camera shall meet or exceed the following illumination specifications:
 - Color: 0.4 lux at 50 IRE, F2.0
 - B/W: 0.03 lux at 50 IRE, F2.0
 - b. Resolution
 - (1) The camera shall be designed to provide video streams in 5 MP at up to 20 frames per second (50HZ/60Hz mode) using H.264 or H265.
 - (2) The camera shall support video resolutions including:
 - 2592x1944 (5 MP, 4:3)
 - 1920x1080 (HDTV 1080p)
 - 1280x720 (HDTV 720p)
 - (3) The camera shall provide landscape format as well as the possibility to adjust the image to stream in corridor format.
 - c. Video streaming
 - (1) The camera shall provide independently configured simultaneous H.264 and H.265 streams.

- (2) The camera shall provide configurable compression levels.
- (3) The camera shall support standard baseline profile with motion estimation.
- (4) The camera shall support motion estimation in H.264/MPEG-4 Part 10/AVC.
- (5) The camera shall support motion estimation in H.265 (MPEG-H Part 2/HEVC)
- (6) The camera shall support the following video encoding algorithms:
 - Main Profile H.264 and H.265 encoding with motion estimation and context-adaptive binary arithmetic coding (CABAC) in up to 20 frames per second.
 - High Profile H.264 encoding with motion estimation up to 20 frames per second.
- (7) The camera shall in H.264 and H.265 support combining Average Bit Rate (ABR) and Maximum Bit Rate (MBR)
- (8) The camera shall be able to deliver predictable storage using Average Bit Rate (ABR) bitrate controlling algorithm based on a bitrate budget and selected retention time.
 - The camera shall be able to deliver predictable storage using Average Bit Rate (ABR) bitrate controlling algorithm based on a bitrate budget and the selected retention time.
 - i. The ABR bitrate algorithm, depending on the bitrate budget and the selected retention time, shall adjust the bitrate to meet the bitrate budget over the whole retention time.
 - ii. The ABR algorithm shall have a method to keep the video quality even during busy periods by allowing the current bitrate to be significantly above the configured average bitrate during significant parts of the retention time.
 - The camera shall in H.264 and H.265 support flexible retention period for Average Bit Rate (ABR) algorithm up to 1 year.
 - When using Average Bit Rate (ABR) the camera shall keep bitrate history up to at least 30 days.
 - The camera shall in H.264 and H.265 support reuse of past Average Bit Rate (ABR) history if a stream is disconnected and the camera reconnects with the same

basic stream parameters.

- When using Average Bit Rate (ABR), the camera shall in H.264 and H.265 support multiple parallel stream with independent ABR-history.
- The camera shall issue bitrate degradation events when using Average Bit Rate (ABR) if the configuration is predicted to be
 - i. unrealistic
 - ii. not fulfilling basic quality requirements
 - iii. not fulfilling the bitrate budget.

(9) The camera shall support scene adaptive bitrate control with one of the following capabilities to lower bandwidth and storage:

- Automatic dynamic Region of Interest to reduce bitrate in unprioritized regions in order to lowering bandwidth and storage requirements.
- Automatic dynamic Group of Pictures to lower bandwidth and storage requirements
- Automatic dynamic Frames per Second to lower bandwidth and storage requirements

d. Transmission

(1) The camera shall allow for video to be transported over:

- HTTP (Unicast)
- HTTPS (Unicast)
- RTP (Unicast & Multicast)
- RTP over RTSP (Unicast)
- RTP over RTSP over HTTP (Unicast)

(2) The camera shall support Quality of Service (QoS) to be able to prioritize traffic.

e. Image

(1) The camera shall incorporate automatic and manual white balance.

(2) The camera shall incorporate an electronic shutter operating in the range of 1/32500s to 1/20s.

- The camera shall incorporate capture mode with capture frequency 50 Hz and 60 Hz

(3) The camera shall incorporate wide dynamic range functionality.

- (4) The camera shall support manually defined values for:
 - Saturation
 - Brightness
 - Sharpness
 - Contrast
- (5) The camera shall incorporate a function for optimization of low light behavior at different light levels.

f. User interface

- (1) Web server
 - The camera shall contain a built-in web server making video and configuration available to multiple clients in a standard operating system and browser environment using HTTP, without the need for additional software.
 - Optional components downloaded from the camera for specific tasks shall be signed by an organization providing digital trust services.
- (2) Language specification
 - The camera shall provide a function for altering the language of the user interface and shall include support for at least 10 different languages.
- (3) IP addresses
 - The camera shall support both fixed IP addresses and dynamically assigned IP addresses provided by a Dynamic Host Control Protocol (DHCP) server.
 - The camera shall allow for automatic detection of the camera based on UPnP and Bonjour when using a computer with an operating system supporting this feature.
 - The camera shall provide support for both IPv4 and IPv6.
 - The camera shall provide support for IPv6 USGv6.

g. Event functionality

- (1) The camera shall be equipped with an integrated event functionality:
 - Device status
 - i. Above operating temperature
 - ii. Above or below operating temperature
 - iii. Below operating temperature

- iv. Fan
- v. IP address
- vi. Network lost
- vii. Storage failure
- viii. System ready
- Edge storage
 - i. Recording ongoing
 - ii. Storage disruption
- I/O
 - i. Manual trigger
 - ii. Virtual input
- PTZ
 - i. PTZ ready
- Scheduled and recurring
- Video
 - i. Day-night mode
 - ii. Live stream open
 - iii. Tampering

(2) Response to triggers shall include event actions:

- Record video: SD card and network share
- Upload of images and video clips: FTP, SFTP, HTTP, HTTPS, network share and email.
- Pre- and post-alarm video or image buffering for recording or upload.
- Notification: email, HTTP, HTTPS, TCP and SNMP trap
- PTZ: PTZ preset
- Overlay text
- Day/night mode
- Status LED
- WDR mode
- Overlay text

(3) The camera shall provide memory for pre- and post-alarm recordings.

h. Storage

(1) The camera shall support continuous and event-controlled recording to:

- Local memory added to the cameras SD-card slot

- Network attached storage, located on the local network
- (2) The camera shall incorporate encryption functionality for the SD card.
 - (3) The camera shall be able to detect and notify edge storage disruptions.
- i. Protocol
- (1) The camera shall incorporate support for at least IPv4, IPv6, USGv6, ICMPv4/ICMPv6, HTTP, HTTP/2, HTTPSa, TLSa, QoS Layer 3 DiffServ, FTP, SFTP, CIFS/SMB, SMTP, mDNS (Bonjour), UPnP, SNMP v1/v2c/v3 (MIB-II), DNS/DNSv6, DDNS, NTP, NTS, RTSP, RTP, SRTP, TCP, UDP, IGMPv1/v2/v3, RTCP, ICMP, DHCPv4/v6, ARP, SSH, NTCIP, LLDP, CDP, MQTT v3.1.1, Secure syslog (RFC 3164/5424, UDP/TCP/TLS), Link-Local address (ZeroConf).
 - (2) The SMTP implementation shall include support for SMTP authentication.
- j. Text overlay
- (1) The camera shall:
 - Provide embedded on-screen text with support for date & time, and a customer-specific text, camera name, of at least 45 ASCII characters.
 - Provide the possibility to choose different font sizes for embedded on-screen text, and to use white or black text on at least four different backgrounds.
 - Provide the ability to manually set up and configure privacy masks to the image.
 - Allow for the overlay of a graphical image, such as a logotype, into the image.
- k. Security
- (1) The camera shall support the following:
 - Secure web browsing
 - i. The use of HTTPS and SSL/TLS, providing the ability to upload signed certificates to encrypt and secure authentication and communication of both administration data and video streams.
 - ii. Restrict access to the built-in web server by usernames and passwords at three different levels.

- Certificate management
 - i. Provide centralized certificate management, with both pre-installed CA certificates and the ability to upload additional CA certificates. The certificates shall be signed by an organization providing digital trust services.
- Enhanced security features
 - i. The use of signed firmware validates the firmware's integrity before accepting to install it.
- Authentication
 - i. IEEE 802.1x (EAP-TLS, PEAP-MSCHAPv2) authentication.
 - ii. Restrict access to pre-defined IP addresses via a host-based firewall.
- Brute force delay protection

(2) Firmware support

- The manufacturer should provide a Software Bill of Material (SBOM) for each product firmware in machine-readable format (CycloneDX, SPDX) that contains information about the software composition of the device's operating system, publicly available for download.
- The manufacturer must provide firmware with long-term support that only contains corrections for critical bugs, security flaws and performance issues.
- The device should maintain high-level cybersecurity without introducing any significant functional changes or affecting any existing integrations.

1. API support

- (1) The camera shall be fully supported by an open and published API (Application Programmers Interface), which shall provide necessary information for integration of functionality into third-party applications.
- (2) The camera shall conform to ONVIF profile G as defined by the ONVIF Organization.
- (3) The camera shall conform to ONVIF profile S as defined by the ONVIF Organization.
- (4) The camera shall conform to ONVIF profile T as defined by the ONVIF Organization.

- m. Embedded applications
 - (1) The camera shall provide a platform allowing the upload of third-party applications into the camera.

- n. Installation and maintenance
 - (1) The camera shall be supplied with Windows-based management software which allows the assignment of IP addresses, upgrade of firmware and backup of the cameras' configuration.
 - (2) The camera shall support the use of SNMP-based management tools according to SNMP v1, 2c & 3 / MIB-II.
 - (3) The camera shall allow updates of the software (firmware) over the network, using FTP or HTTP.
 - (4) The camera shall accept external time synchronization from an NTP (Network Time Protocol) server.
 - (5) The camera shall store all customer-specific settings in a non-volatile memory that shall not be lost during power cuts or soft reset.

- o. Access log
 - (1) The camera shall provide a log file, containing information about the 250 latest connections and access attempts since the unit's latest restart. The file shall include information about the connecting IP addresses and the time of connecting.
 - (2) The camera shall provide a connection list of all currently connected viewers. The file shall include information about connecting IP address, time of connecting and the type of stream accessed.

- p. Camera diagnostics
 - (1) The camera shall be equipped with LEDs, capable of providing visible status information. LEDs shall indicate the camera's operational status and provide information about power, communication with receiver, the network status and the camera status.
 - (2) The camera shall be monitored by a Watchdog functionality, which shall automatically re-initiate processes or restart the unit if a malfunction is detected.
 - (3) The camera shall send a notification when the unit has rebooted, and all services are initialized.

- q. Hardware interfaces
- (1) Network interface
 - The camera shall be equipped with one 10BASE-T/100BASE-TX/1000BASE-T Ethernet-port using a RJ45 connector and shall support auto negotiation of network speed and transfer mode (full and half duplex).
 - (2) Inputs/Outputs
 - The camera shall be equipped with two configurable I/O ports, accessible via a removable terminal block. These inputs/outputs shall be configurable to respond to normally open (NO) or normally closed (NC) dry contacts. The output shall be able to provide 12 V DC, 50 mA.
- r. Enclosure
- (1) The camera shall:
 - Be manufactured with an IP66-, NEMA 4X- and IK10-rated Polycarbonate dome Aluminum casing
- s. Power
- (1) The camera shall provide power over Ethernet IEEE 802.1x
 - Max: 22W
 - Typical: 9W
 - (2) 24 V DC
 - Max: 75W
 - Typical: 9W
 - (3) 24 V AC
 - Max: 97 VA
 - Typical: 16 VA
- t. Environmental
- (1) The camera shall:
 - Operate in a temperature range of -40°C to 50°C (-40°F to 122°F)
 - Operate in a temperature range of -50°C to 50°C (-58°F to 122°F) with manufacturer's camera heater kit
 - Start-up temperature: -40°C (-40°F)

- Operate in a maximum temperature 74 °C (165 °F)
- Operate in a humidity range of 10–100% RH (condensing)

B. Outdoor-ready PTZ with HDTV 1080p and 40x optical zoom

1. The specified product shall meet or exceed the following design specifications:
 - a. The product shall operate on an open source and Linux-based platform, and include a built-in web server.
 - b. The product shall be equipped with an IR-sensitive progressive scan megapixel sensor.
 - c. The product shall provide a removable IR-cut filter, providing day/night functionality.
 - d. The product shall be equipped with a 4.25-170 mm lens with auto-iris and autofocus.
 - e. The product shall be equipped with a motorized 40x optical zoom lens, providing a horizontal field of view between 65.1 and 2.00 and a vertical field of view between 39.1 and 1.18.
 - f. The product shall be manufactured with a metal (aluminum) casing.
 - g. The product shall provide local video storage utilizing a SD/SDHC/SDXC memory card expansion.
 - h. The product shall be manufactured with an UV-resistant IP66/67, NEMA 250 4X- and IK10-rated polymer enclosure fitted with a fixed sunshield.
 - i. The product shall provide options for clear and smoked dome
2. The specified product shall meet or exceed the following performance specifications:
 - a. Illumination
 - (1) The product shall meet or exceed the following illumination specifications:
 - Color:
 - i. 0.1 lux at 30 IRE, F1.6
 - ii. 0.15 lux at 50 IRE, F1.6
 - B/W:
 - i. 0.002 lux at 30 IRE, F1.6
 - ii. 0.003 lux at 50 IRE, F1.6
 - b. Resolution

- (1) The product shall be designed to provide video streams in HDTV 1080p (1920x1080) at up to 60 frames per second (60Hz mode) or 50 frames per second (50Hz mode) using H.264, H.265 or Motion JPEG.
- (2) The product shall support video resolutions including:
 - 1920x1080 (HDTV 1080p)
 - 1280x720 (HDTV 720p)

c. Video streaming

- (1) The product shall provide independently configured simultaneous H.264 and Motion JPEG streams.
- (2) The product shall provide configurable compression levels.
- (3) The product shall support standard baseline profile with motion estimation.
- (4) The product shall support motion estimation in H.264/MPEG-4 Part 10/AVC.
- (5) The product shall support the following video encoding algorithms:
 - Motion JPEG encoding in a selectable range from 1 up to 50/60 frames per second.
 - Baseline Profile H.264 encoding with motion estimation in up to 50/60 frames per second.
 - Main Profile H.265 encoding with motion estimation and context-adaptive binary arithmetic coding (CABAC) in up to 50/60 frames per second.
 - High Profile H.264 encoding with motion estimation up to 50/60 frames per second.
- (6) The camera shall in H.264 and H.265 support combining Average Bit Rate (ABR) and Maximum Bit Rate (MBR)
- (7) The camera shall be able to deliver predictable storage using Average Bit Rate (ABR) bitrate controlling algorithm based on a bitrate budget and selected retention time.
 - The camera shall be able to deliver predictable storage using Average Bit Rate (ABR) bitrate controlling algorithm based on a bitrate budget and the selected retention time.
 - i. The ABR bitrate algorithm, depending on the bitrate budget and the selected retention time, shall adjust the bitrate to meet the bitrate

budget over the whole retention time.

ii. The ABR algorithm shall have a method to keep the video quality even during busy periods by allowing the current bitrate to be significantly above the configured average bitrate during significant parts of the retention time.

- The camera shall in H.264 and H.265 support flexible retention period for Average Bit Rate (ABR) algorithm up to 1 year.
- When using Average Bit Rate (ABR) the camera shall keep bitrate history up to at least 30 days.
- The camera shall in H.264 and H.265 support reuse of past Average Bit Rate (ABR) history if a stream is disconnected and the camera reconnects with the same basic stream parameters.
- When using Average Bit Rate (ABR), the camera shall in H.264 and H.265 support multiple parallel stream with independent ABR-history.
- The camera shall issue bitrate degradation events when using Average Bit Rate (ABR) if the configuration is predicted to be
 - i. unrealistic
 - ii. not fulfilling basic quality requirements
 - iii. not fulfilling the bitrate budget

(8) The product shall support scene adaptive bitrate control with one of the following capabilities to lower bandwidth and storage:

- Automatic dynamic Region of Interest to reduce bitrate in unprioritized regions in order to lowering bandwidth and storage requirements.
- Automatic dynamic Group of Pictures to lower bandwidth and storage requirements
- Automatic dynamic Frames per Second to lower bandwidth and storage requirements

d. Transmission

(1) The product shall allow for video to be transported over:

- HTTP (Unicast)
- HTTPS (Unicast)
- RTP (Unicast & Multicast)
- RTP over RTSP (Unicast)

- RTP over RTSP over HTTP (Unicast)
- SRTP/RTSPS (Unicast & Multicast)

(2) The product shall support Quality of Service (QoS) to be able to prioritize traffic.

e. Image

(1) The product shall incorporate automatic and manual white balance.

(2) The product shall incorporate an electronic shutter operating in the range of 1/11000 s to 1/3 s.

(3) The product shall incorporate capture mode with the following settings:

- HDTV 1080p (1920x1080) with WDR: 25/30 fps (50/60 Hz)
- HDTV 1080p (1920x1080) without WDR: Up to 50/60 fps (50/60 Hz)

(4) The product shall incorporate forensic wide dynamic range functionality providing up to 120 dB dynamic range.

(5) The product shall provide backlight compensation functionality.

(6) The product shall support manually defined values for:

- Saturation
- Brightness
- Sharpness
- Contrast

(7) The product shall incorporate a function for optimization of low light behavior.

(8) The product shall allow for rotation of the image in steps of 180°.

(9) The product shall incorporate automatic defog functionality.

f. User Interface

(1) Web server

- The product shall contain a built-in web server making video and configuration available to multiple clients in a standard operating system and browser environment using HTTP, without the need for additional software.
- Optional components downloaded from the product for

specific tasks shall be signed by an organization providing digital trust services.

(2) Language Specification

- The product shall provide a function for altering the language of the user interface, and shall include support for at least 10 different languages.

(3) IP addresses

- The product shall support both fixed IP addresses and dynamically assigned IP addresses provided by a Dynamic Host Control Protocol (DHCP) server.
- The product shall allow for automatic detection of the product based on UPnP and Bonjour when using a computer with an operating system supporting this feature.
- The product shall provide support for both IPv4 and IPv6.
- The camera shall provide support for IPv6 USGv6.

g. PTZ functionality

(1) The product shall:

- Provide digital PTZ functionality.
- Provide more than 255 manually set preset positions.
- Provide On-screen directional indicator (OSDI) functionality.
- Be equipped with accurate pan and tilt functionality with a range of:
 - i. Pan: 360 endless
 - ii. Tilt: 220
- Provide pan and tilt speed in a range of:
 - i. Pan: 0.05 - 450/sec
 - ii. Tilt: 0.05 - 450/sec
- Provide optical and digital zoom functionality:
 - i. Optical zoom: 40x
 - ii. Digital zoom: 12x
- Provide adjustable zoom speed.
- Provide e-flip functionality, which will automatically rotate the image 180 electronically when following a moving object passing under the camera.
- Provide a guard tour functionality which allows the dome to automatically move between selected presets using an individual speed and viewing time for each preset.

h. Event functionality

(1) The product shall be equipped with an integrated event functionality:

- Device status
 - i. Operating temperature
 - ii. Fan
 - iii. IP address
 - iv. Network lost
 - v. Shock detection
 - vi. Storage failure
 - vii. System ready
- Edge storage
 - i. Recording ongoing
 - ii. Storage disruption
- I/O
 - i. Manual trigger
 - ii. Virtual inputs
- PTZ
 - i. Malfunctioning
 - ii. Movement
 - iii. Preset position reached
 - iv. Ready
- Scheduled and recurring
- Video
 - i. Average bitrate degradation
 - ii. Live stream open

(2) Response to triggers shall include event actions:

- Day and night mode
- Guard tours
- Upload of images and video clips: FTP, SFTP, HTTP, HTTPS, email or network share
- Send notification: email, HTTP, HTTPS, TCP and SNMP trap
- Overlay text
- Preset positions
- Record video: SD card and network share
- Send SNMP trap message

(3) The product shall provide memory for pre- and post-alarm recordings.

i. Edge storage

- (1) The product shall support continuous and event controlled recording to:
 - Local memory added to the products SD-card slot
 - Network attached storage, located on the local network
- (2) The product shall incorporate encryption functionality for the SD card (AES-XTS-Plain64 256bit).
- (3) The product shall be able to detect and notify edge storage disruptions.

j. Protocol

- (1) The product shall incorporate support for at least IPv4, IPv6 USGv6, ICMPv4/ICMPv6, HTTP, HTTP/2, HTTPSa , TLSa , QoS Layer 3 DiffServ, FTP, SFTP, CIFS/SMB, SMTP, mDNS (Bonjour), UPnP® , SNMP v1/v2c/v3 (MIB-II), DNS/DNSv6, DDNS, NTP, NTS, RTSP, RTP, SRTP/RTSPS, TCP, UDP, IGMPv1/v2/v3, RTCP, ICMP, DHCPv4/v6, ARP, SSH, NTCIP, LLDP, CDP, MQTT, Secure syslog (RFC 3164/5424, UDP/TCP/TLS), Link-Local address (ZeroConf).
- (2) The SMTP implementation shall include support for SMTP authentication.

k. Text overlay

- (1) The product shall:
 - Provide embedded on-screen text with support for date & time, and a customer-specific text, product name, of at least 45 ASCII characters.
 - Provide the possibility to choose different font sizes for embedded on-screen text, and to use white or black text on at least four different backgrounds.
 - Provide the ability to manually set up and configure polygon privacy masks to the image.
 - Allow for the overlay of a graphical image, such as a logotype, into the image.

l. Security

- (1) The camera shall support the following:
 - Secure web browsing
 - i. The use of HTTPS and TLS, providing the ability to upload signed certificates to encrypt

- and secure authentication and communication of both administration data and video streams.
 - ii. Restrict access to the built-in web server by usernames and passwords at three different levels.
 - Certificate management
 - i. Provide centralized certificate management, with both pre-installed CA certificates and the ability to upload additional CA certificates. The certificates shall be signed by an organization providing digital trust services.
 - Enhanced security features
 - i. The use of signed firmware validates the firmware's integrity before accepting to install it.
 - ii. The use of a secure boot process, based on the use of signed firmware, ensures that the camera can boot only with authorized firmware.
 - iii. The use of signed video (adding cryptographic checksum to H.264 videos signed by the manufacturer's secured device ID) provides support for validating the video's authenticity and origin.
 - iv. The product shall include a tamper-resistant hardware module, certified to at least Common Criteria EAL4+. The trusted platform module (TPM) shall provide a set of cryptographic features suitable for protecting private keys from unauthorized access. TPM is certified according to FIPS 140-2 level 2.
 - v. The use of a cryptographically verifiable hardware module where a collection of certificates, required to verify device identification, is installed.
 - vi. The product shall include a tamper-resistant hardware module, certified to at least Common Criteria EAL4.
 - Authentication
 - i. IEEE 802.1x (EAP-TLS, PEAP-MSCHAPv2) authentication.
 - ii. IEEE 802.1AE (MACsec PSK/EAP-TLS) authentication.

- iii. Restrict access to pre-defined IP addresses via a host-based firewall.
 - Brute force delay protection
 - (2) Firmware support
 - The manufacturer should provide a Software Bill of Material (SBOM) for each product firmware in machine-readable format (CycloneDX, SPDX) that contains information about the software composition of the device's operating system, publicly available for download.
 - The manufacturer must provide firmware with long-term support that only contains corrections for critical bugs, security flaws and performance issues.
 - The device should maintain high-level cybersecurity without introducing any significant functional changes or affecting any existing integrations.
- m. System integration
- (1) The camera shall be fully supported by an open and published API (Application Programmers Interface), which shall provide necessary information for integration of functionality into third-party applications.
 - (2) The camera shall conform to ONVIF profile G as defined by the ONVIF Organization.
 - (3) The camera shall conform to ONVIF profile S as defined by the ONVIF Organization.
 - (4) The camera shall conform to ONVIF profile T as defined by the ONVIF Organization.
 - (5) The camera shall conform to ONVIF profile M as defined by the ONVIF Organization.
- n. Analytics
- (1) The camera shall provide a platform allowing the upload of third-party applications into the camera.
 - (2) The camera shall support advanced video analytics capabilities with a built-in hardware-accelerated object detect engine, capable of automatically detecting several simultaneously visible objects from a set of pre-trained object categories (such as vehicles, license plates, people and faces).
 - (3) The camera shall be supplied with preinstalled advanced video

analytics capabilities, capable of detecting and classifying humans and vehicles in non-critical indoor and outdoor spaces.

- The camera shall provide a function to measure how long an object (human or vehicle) stayed in a monitored area.

o. Installation and maintenance

- (1) The product shall be supplied with Windows-based management software which allows the assignment of IP addresses, upgrade of firmware and backup of the products' configuration.
- (2) The product shall support the use of SNMP-based management tools according to SNMP v1, 2c & 3 / MIB-II.
- (3) The product shall allow updates of the software (firmware) over the network, using FTP or HTTP.
- (4) The product shall provide the ability to apply a rectangle of customer-defined number of pixels to the image, which can be used as a pixel counter identifying the size of objects in number of pixels.
- (5) The product shall accept external time synchronization from an NTP (Network Time Protocol) server.
- (6) The product shall store all customer-specific settings in a non-volatile memory that shall not be lost during power cuts or soft reset.

p. Access log

- (1) The product shall provide a log file, containing information about the 250 latest connections and access attempts since the unit's latest restart. The file shall include information about the connecting IP addresses and the time of connecting.
- (2) The product shall provide a connection list of all currently connected viewers. The file shall include information about connecting IP address, time of connecting and the type of stream accessed.

q. Camera diagnostics

- (1) The product shall be equipped with LEDs, capable of providing visible status information. LEDs shall indicate the product's operational status and provide information about power, communication with receiver, the network status and the product status.
- (2) The product shall be monitored by a Watchdog functionality, which shall automatically re-initiate processes or restart the unit if

a malfunction is detected.

- (3) The product shall send a notification when the unit has rebooted and all services are initialized.

r. Hardware interfaces

(1) Network interface

- The product shall be equipped with one 10BASE-T/100BASE-TX Ethernet-port using a RJ45 connector and shall support auto negotiation of network speed (100 MBit/s and 10 MBit/s) and transfer mode (full and half duplex).

s. Enclosure

(1) The product shall:

- Be manufactured with an IP66/67-, NEMA250 4X- and IK10-rated aluminum enclosure.
- Be fitted with a fixed sunshield.

t. Power

(1) The product shall be connected to a separate midspan and obtain power through a network cable. The midspan shall use 100-240 V AC/50-60 Hz, max 66.1 W, and provide the product with a maximum of:

- 51 W when using a 60 W midspan

u. Environmental

(1) The product shall:

- Operate in a temperature range of -20 °C to 50 °C (-4 °F to 122 °F) (with 30 W)
- Operate in a temperature range of -50 °C to 50 °C (-58 °F to 122 °F) (with 60 W)
- Operate in a maximum temperature (intermittent) of 74 °C (165 F)
- Be able to start-up as low as -40 °C (-40 °F) (arctic temperature control)
- Operate in a humidity range of 10–100% RH (condensing).

C. Dual-sensor panoramic camera

1. The specified product shall meet or exceed the following design specifications:

- a. The camera shall operate on an open source and Linux-based platform, and include a built-in web server.
 - b. The camera shall provide a removable IR-cut filter, providing day/night functionality.
 - c. The camera shall be equipped with two varifocal 3.3–8.1 mm IR-corrected lenses with a 2 MP image sensor with fixed iris, a 2.5x remote zoom and remote focus.
 - d. The camera shall provide the following fields of view and focus distance:
 - (1) Horizontal: 107° and 39°
 - (2) Vertical: 55° and 22°
 - (3) Diagonal: 131° and 45°
 - (4) Focus distance: 0.5 m (1.6 ft)
 - e. The camera shall provide local video storage utilizing a microSD/microSDHC/microSDXC memory card expansion.
 - f. The camera shall be manufactured with an IP66-, IP67-, NEMA 4X- and IK10-rated aluminum and plastic casing with a polycarbonate hard-coated dome.
 - g. The camera shall provide a manual 3-axis (pan/tilt/rotation) positioning to allow adjustment for optimum camera rotation and placement.
 - h. The camera shall provide options for clear and smoked lower dome
2. The specified product shall meet or exceed the following performance specifications:
- a. Illumination
 - (1) The camera shall meet or exceed the following illumination specifications:
 - Color: 0.1 lux at 50 IRE, F1.9
 - B/W: 0 lux at 50 IRE, F1.9
 - 0 lux with IR illumination on
 - b. Resolution
 - (1) The camera shall be designed to provide video streams in 2x HDTV 1080p (1920x1080) at up to 60 frames per second (60Hz mode) or 50 frames per second (50Hz mode) using H.264, H.265 or Motion JPEG.

- (2) The camera shall support video resolutions including:
 - 2x 1920x1080 (2x HDTV 1080p)
 - 2x 1280x720 (2x HDTV 720p)
- (3) The camera shall provide both landscape format (4:3 and 16:9 aspect ratio) as well as corridor format (3:4 and 9:16 aspect ratio).

c. Video streaming

- (1) The camera shall provide independently configured H.264, H.265 and Motion JPEG streams.
- (2) The camera shall provide configurable compression levels.
- (3) The camera shall provide a video streaming indicator.
- (4) The camera shall support standard baseline profile with motion estimation.
- (5) The camera shall support motion estimation in H.264/MPEG-4 Part 10/AVC.
- (6) The camera shall support motion estimation in H.265 (MPEG-H Part 2/HEVC)
- (7) The camera shall support the following video encoding algorithms:
 - Motion JPEG encoding in a selectable range from 1 up to 50/60 frames per second.
 - Baseline Profile H.264 encoding with motion estimation in up to 50/60 frames per second.
 - Main Profile H.264 and H.265 encoding with motion estimation and context-adaptive binary arithmetic coding (CABAC) in up to 50/60 frames per second.
 - High Profile H.264 encoding with motion estimation up to 50/60 frames per second.
- (8) The camera shall in H.264 and H.265 support Variable Bit Rate (VBR), Average Bit Rate (ABR) and Maximum Bit Rate (MBR).
- (9) The camera shall be able to deliver predictable storage using Average Bit Rate (ABR) bitrate controlling algorithm based on a bitrate budget and selected retention time.
 - The camera shall be able to deliver predictable storage using Average Bit Rate (ABR) bitrate controlling algorithm based on a bitrate budget and the selected retention time.

- i. The ABR bitrate algorithm, depending on the bitrate budget and the selected retention time, shall adjust the bitrate to meet the bitrate budget over the whole retention time.
 - ii. The ABR algorithm shall have a method to keep the video quality even during busy periods by allowing the current bitrate to be significantly above the configured average bitrate during significant parts of the retention time.
 - The camera shall in H.264 and H.265 support flexible retention period for Average Bit Rate (ABR) algorithm up to 1 year.
 - When using Average Bit Rate (ABR) the camera shall keep bitrate history up to at least 30 days.
 - The camera shall in H.264 and H.265 support reuse of past Average Bit Rate (ABR) history if a stream is disconnected and the camera reconnects with the same basic stream parameters.
 - When using Average Bit Rate (ABR), the camera shall in H.264 and H.265 support multiple parallel stream with independent ABR-history.
 - The camera shall issue bitrate degradation events when using Average Bit Rate (ABR) if the configuration is predicted to be
 - iii. unrealistic
 - iv. not fulfilling basic quality requirements
 - v. not fulfilling the bitrate budget.
- (10) The camera shall support scene adaptive bitrate control with one of the following capabilities to lower bandwidth and storage:
- Automatic dynamic Region of Interest to reduce bitrate in unprioritized regions in order to lowering bandwidth and storage requirements.
 - Automatic dynamic Group of Pictures to lower bandwidth and storage requirements
 - Automatic dynamic Frames per Second to lower bandwidth and storage requirements
- (11) The camera shall support optimized image processing time for live streams by reducing the latency in live streams to the minimum.
- d. Transmission
- (1) The camera shall allow for video to be transported over:

- HTTP (Unicast)
- HTTPS (Unicast)
- RTP (Unicast & Multicast)
- RTP over RTSP (Unicast)
- RTP over RTSP over HTTP (Unicast)
- SRTP (Unicast & Multicast)

(2) The camera shall support Quality of Service (QoS) to be able to prioritize traffic.

e. Image

(1) The camera shall incorporate automatic and manual white balance.

(2) The camera shall incorporate an electronic shutter operating in the range of 1/20000 s to 1.5 s.

(3) The camera shall incorporate capture mode with the following settings:

- 2x HDTV 1080p (1920x1080) with WDR: 25/30 fps (50/60 Hz)
- 2x HDTV 1080p (1920x1080) without WDR: Up to 50/60 fps (50/60 Hz)

(4) The camera shall incorporate wide dynamic range – forensic WDR functionality.

(5) The camera shall incorporate forensic wide dynamic range functionality providing up to 120 dB dynamic range.

(6) The camera shall support manually defined values for:

- Saturation
- Brightness
- Sharpness
- Contrast

(7) The camera shall incorporate a function for optimization of low-light behavior at different light levels.

(8) The camera shall allow for rotation of the image in steps of 90°.

f. Audio

(1) The camera shall support two-way audio connectivity via edge-to-

edge technology.

(2) The camera shall support one-way simplex audio:

- Input/output sources
 - i. External microphone input
 - ii. External line device
 - iii. Ring power technology (with selected microphone models)
 - iv. Digital audio input
 - v. Automatic gain control

(3) Encoding

- The camera shall support:
 - i. 24bit LPCM
 - ii. AAC-LC 8/16/32/44.1/48 kHz
 - iii. G.711 PCM 8 kHz
 - iv. G.726 ADPCM 8 kHz
 - v. Opus 8/16/48 kHz
 - vi. Configurable bit rate

g. IR Illumination

(1) The camera shall be equipped with built-in IR LEDs, with a range of up to 15 m (50 ft) with a wavelength of 850 nm.

(2) The camera shall be equipped with built-in IR LEDs with automatic seamless adapting angle of illumination and intensity.

h. User Interface

(1) Web server

- The camera shall contain a built-in web server making video and configuration available to multiple clients in a standard operating system and browser environment using HTTP, without the need for additional software.
- Optional components downloaded from the camera for specific tasks shall be signed by an organization providing digital trust services.

(2) Language Specification

- The camera shall provide a function for altering the language of the user interface, and shall include support for at least 10 different languages.

(3) IP addresses

- The camera shall support both fixed IP addresses and dynamically assigned IP addresses provided by a

Dynamic Host Control Protocol (DHCP) server.

- The camera shall allow for automatic detection of the camera based on UPnP and Bonjour when using a computer with an operating system supporting this feature.
- The camera shall provide support for both IPv4 and IPv6.
- The camera shall provide support for IPv6 USGv6.

i. Event conditions

(1) The camera shall be equipped with an integrated event functionality:

- Analytics
- Virtual inputs through API
- Audio
 - i. Audio detection
- Device status
 - i. Operating temperature failure
 - ii. IP address
 - iii. Network lost
 - iv. System ready
 - v. Ring power overcurrent protection
 - vi. Live stream active
 - vii. Casing open
- Digital audio:
 - i. Digital signal
- Edge storage
 - i. Recording ongoing
 - ii. Storage disruption
 - iii. Storage health
- I/O
 - i. Manual trigger
 - ii. Virtual inputs
- MQTT subscribe
- Scheduled and recurring
- Video
 - i. Average bitrate degradation
 - ii. Day-night mode
 - iii. Live stream open
 - iv. Tampering

(2) Response to triggers shall include event actions:

- Overlay text
 - Day/night mode
 - Flash status LED
 - Audio clips: play, stop
 - Illumination: use lights, use lights while the rule is active
 - MQTT: Publish
 - Notification: HTTP, HTTPS, TCP and email
 - Pre- and post-alarm video or image buffering for recording or upload
 - Record video: SD card and network share
 - SNMP traps: send, sent while the rule is active
 - Upload of images or video clips: FTP, SFTP, HTTP, HTTPS, network share and email
- (3) The camera shall provide memory for pre- and post-alarm recordings.

j. Storage

- (1) The camera shall support continuous and event controlled recording to:
- Local memory added to the cameras microSD-card slot
 - Network attached storage, located on the local network
- (2) The camera shall incorporate encryption functionality for the SD card (AES-XTS-Plain64 256bit).
- (3) The camera shall incorporate encryption functionality for the SD card.
- (4) The camera shall be able to detect and notify edge storage disruptions.

k. Protocol

- (1) The camera shall incorporate support for at least IPv4, IPv6 USGv6, ICMPv4/ICMPv6, HTTP, HTTPSa , HTTP/2, TLSa , QoS Layer 3 DiffServ, FTP, SFTP, CIFS/SMB, SMTP, mDNS (Bonjour), UPnP® , SNMP v1/v2c/v3 (MIB-II), DNS/DNSv6, DDNS, NTP, NTS, RTSP, RTCP, RTP, SRTP/RTSPS, TCP, UDP, IGMPv1/v2/v3, DHCPv4/v6, ARP, SSH, LLDP, CDP, MQTT v3.1.1, Secure syslog (RFC 3164/5424, UDP/TCP/TLS), Link-Local address (ZeroConf).
- (2) The SMTP implementation shall include support for SMTP

authentication.

l. Text overlay

(1) The camera shall:

- Provide embedded on-screen text with support for date & time, and a customer-specific text, camera name, of at least 45 ASCII characters.
- Provide the possibility to choose different font sizes for embedded on-screen text, and to use white or black text on at least four different backgrounds.
- Provide the ability to manually set up and configure privacy masks to the image.

m. Security

(1) The camera shall support the following:

- Secure web browsing
 - i. The use of HTTPS and TLS, providing the ability to upload signed certificates to encrypt and secure authentication and communication of both administration data and video streams.
 - ii. Restrict access to the built-in web server by usernames and passwords at three different levels.
- Certificate management
 - i. Provide centralized certificate management, with both pre-installed CA certificates and the ability to upload additional CA certificates. The certificates shall be signed by an organization providing digital trust services.
- Enhanced security features
 - i. The use of signed firmware validates the firmware's integrity before accepting to install it.
 - ii. The use of a secure boot process, based on the use of signed firmware, ensures that the camera can boot only with authorized firmware.
 - iii. The product shall include a tamper-resistant hardware module, certified to at least Common Criteria EAL4+. The trusted platform module (TPM) shall provide a set of

cryptographic features suitable for protecting private keys from unauthorized access. TPM is certified according to FIPS 140-2 level 2.

- iv. The use of a cryptographically verifiable hardware module where a collection of certificates, required to verify device identification, is installed.
- v. Support for encrypted filesystem (AES-XTS-Plain64 256bit).
- vi. The collection of certificates (using IEEE 802.1AR) proves that the device and its firmware are authentic and produced by the manufacturer.

- Authentication
 - i. IEEE 802.1x (EAP-TLS, PEAP-MSCHAPv2) authentication.
 - ii. IEEE 802.1AE (MACsec PSK/EAP-TLS) authentication.
 - iii. Restrict access to pre-defined IP addresses via a host-based firewall.
- Brute force delay protection

(2) Firmware support

- The manufacturer should provide a Software Bill of Material (SBOM) for each product firmware in machine-readable format (CycloneDX, SPDX) that contains information about the software composition of the device's operating system, publicly available for download.
- The manufacturer must provide firmware with long-term support that only contains corrections for critical bugs, security flaws and performance issues.
- The device should maintain high-level cybersecurity without introducing any significant functional changes or affecting any existing integrations.

n. System integration

- (1) The camera shall be fully supported by an open and published API (Application Programmers Interface), which shall provide necessary information for integration of functionality into third-party applications.
- (2) The camera shall conform to ONVIF profile G as defined by the ONVIF Organization.
- (3) The camera shall conform to ONVIF profile M as defined by the

ONVIF Organization.

- (4) The camera shall conform to ONVIF profile S as defined by the ONVIF Organization.
- (5) The camera shall conform to ONVIF profile T as defined by the ONVIF Organization.

o. Analytics

- (1) The camera shall provide a platform allowing the upload of third-party applications into the camera.
- (2) The camera shall be equipped with a built-in, deep-learning processing unit capable of executing neural network algorithms, such as object detection, classification and segmentation (including vehicle types, license plates, people and faces). The deep-learning processing unit shall contain multiple parallel hardware accelerated compute resources capable of performing real-time video inference. The camera manufacturer shall support approved third-party developers to enable custom made deep-learning applications using the DLPU to accelerate custom trained deep-learning networks with commonly available network architectures.
- (3) The camera shall be supplied with preinstalled advanced video analytics capabilities, capable of detecting and classifying humans and vehicles in non-critical indoor and outdoor spaces.

p. Installation and maintenance

- (1) The camera shall be supplied with Windows-based management software which allows the assignment of IP addresses, upgrade of firmware and backup of the cameras' configuration.
- (2) The camera shall support the use of SNMP-based management tools according to SNMP v1, 2c & 3 / MIB-II.
- (3) The camera shall allow updates of the software (firmware) over the network, using FTP or HTTP.
- (4) The camera shall store all customer-specific settings in a non-volatile memory that shall not be lost during power cuts or soft reset.
- (5) The camera shall provide the ability to apply a rectangle of customer-defined number of pixels to the image, which can be used as a pixel counter identifying the size of objects in number of pixels.
- (6) The camera shall accept external time synchronization from an

NTP (Network Time Protocol) server.

- (7) The camera shall provide remote zoom and remote focus functionality.

q. Access log

- (1) The camera shall provide a log file, containing information about the 250 latest connections and access attempts since the unit's latest restart. The file shall include information about the connecting IP addresses and the time of connecting.
- (2) The camera shall provide a connection list of all currently connected viewers. The file shall include information about connecting IP address, time of connecting and the type of stream accessed.

r. Camera diagnostics

- (1) The camera shall be equipped with LEDs, capable of providing visible status information. LEDs shall indicate the camera's operational status and provide information about power, communication with receiver, the network status and the camera status.
- (2) The camera shall be monitored by a Watchdog functionality, which shall automatically re-initiate processes or restart the unit if a malfunction is detected.
- (3) The camera shall send a notification when the unit has rebooted and all services are initialized.

s. Hardware interfaces

- (1) Network interface
 - The camera shall be equipped with one 10BASE-T/100BASE-TX/1000BASE-T Ethernet-port using a RJ45 connector and shall support auto negotiation of network speed and transfer mode (full and half duplex).
- (2) Audio
 - The camera shall be equipped with one 3.5 mm jack for line/mic input and one 3.5 mm jack for line output.

t. Enclosure

- (1) The camera shall:
 - Be manufactured with an IP66-, IP67-, NEMA 4X- and IK10-rated aluminum and plastic casing with a polycarbonate hard-coated dome.

- Be fitted with a fixed weather shield.
- u. Power
- (1) The camera shall provide power over Ethernet IEEE 802.3at Type 2 Class 4
- Max: 17.5 W
 - Typical: 7.9 W
- v. Environmental
- (1) The camera shall:
- Operate in a temperature range of -30 °C to 50 °C (-22 °F to 122 °F)
 - Operate in a maximum temperature (intermittent) of 74 °C (165 °F)
 - Operate in a humidity range of 10–100% RH (non-condensing).

D. 4x 4K multidirectional network camera

1. The specified product shall meet or exceed the following design specifications:
- a. The camera shall operate on an open source and Linux-based platform, and include a built-in web server.
 - b. The camera shall provide an automatic IR-cut filter, providing day/night functionality.
 - c. The camera shall be equipped with a 3.2–8.1 mm varifocal IR-corrected megapixel lens with 4x 4K image sensor.
 - d. The camera shall be equipped with remote zoom and focus, providing a horizontal field of view between 108° and 40°, a vertical field of view between 55° and 23° and a diagonal field of view between 131° and 46°.
 - e. The camera shall provide local video storage utilizing a microSD/microSDHC/microSDXC memory card expansion.
 - f. The camera shall be manufactured with a repaintable metal (aluminum) casing.
 - g. The camera shall be manufactured with an IP66-, IP67-, NEMA 4X- and IK09-rated aluminum and plastic casing with a polycarbonate hard coated dome.
 - h. The camera shall provide a manual 3-axis (pan/tilt/rotation) positioning to allow adjustment for optimum camera rotation and placement.

- i. The camera shall provide options for clear and smoked lower dome
2. The specified product shall meet or exceed the following performance specifications:
 - a. Illumination
 - (1) The camera shall meet or exceed the following illumination specifications:
 - Color: 0.19 lux at 50 IRE, F1.9
 - B/W: 0 lux at 50 IRE, F1.9
 - 0 lux with IR illumination on
 - b. Resolution
 - (1) The camera shall be designed to provide video streams including:
 - 4X 5 MP (2592x1944) at up to 20 frames per second (60Hz mode) or 20 frames per second (50Hz mode) using H.264, H265 or Motion JPEG.
 - 4X Quad HD (2560x1440) at up to 30 frames per second (60Hz mode) or 25 frames per second (50Hz mode) using H.264, H265 or Motion JPEG.
 - (2) The camera shall support video resolutions including:
 - 4x 3840x2160 (4K)
 - 4x 1920x1080 (2 MP)
 - 4x 1280x720 (HDTV 720p)
 - (3) The camera shall provide both landscape format (4:3 and 16:9 aspect ratio) as well as corridor format (3:4 and 9:16 aspect ratio).
 - c. Video streaming
 - (1) The camera shall provide independently configured H.264, H.265 and Motion JPEG streams.
 - (2) The camera shall provide configurable compression levels.
 - (3) The camera shall provide a video streaming indicator.
 - (4) The camera shall support standard baseline profile with motion estimation.
 - (5) The camera shall support motion estimation in H.264/MPEG-4 Part 10/AVC.
 - (6) The camera shall support motion estimation in H.265 (MPEG-H

Part 2/HEVC

- (7) The camera shall support the following video encoding algorithms:
- Motion JPEG encoding in a selectable range from 1 up to 25/30 frames per second.
 - Baseline Profile H.264 encoding with motion estimation in up to 25/30 frames per second.
 - Main Profile H.264 and H.265 encoding with motion estimation and context-adaptive binary arithmetic coding (CABAC) in up to 25/30 frames per second.
 - High Profile H.264 encoding with motion estimation up to 25/30 frames per second.
- (8) The camera shall in H.264 and H.265 support Variable Bit Rate (VBR), Average Bit Rate (ABR) and Maximum Bit Rate (MBR).
- (9) The camera shall be able to deliver predictable storage using Average Bit Rate (ABR) bitrate controlling algorithm based on a bitrate budget and selected retention time.
- The camera shall be able to deliver predictable storage using Average Bit Rate (ABR) bitrate controlling algorithm based on a bitrate budget and the selected retention time.
 - i. The ABR bitrate algorithm, depending on the bitrate budget and the selected retention time, shall adjust the bitrate to meet the bitrate budget over the whole retention time.
 - ii. The ABR algorithm shall have a method to keep the video quality even during busy periods by allowing the current bitrate to be significantly above the configured average bitrate during significant parts of the retention time.
 - The camera shall in H.264 and H.265 support flexible retention period for Average Bit Rate (ABR) algorithm up to 1 year.
 - When using Average Bit Rate (ABR) the camera shall keep bitrate history up to at least 30 days.
 - The camera shall in H.264 and H.265 support reuse of past Average Bit Rate (ABR) history if a stream is disconnected and the camera reconnects with the same basic stream parameters.
 - When using Average Bit Rate (ABR), the camera shall in H.264 and H.265 support multiple parallel stream with

independent ABR-history.

- The camera shall issue bitrate degradation events when using Average Bit Rate (ABR) if the configuration is predicted to be
 - i. unrealistic
 - ii. not fulfilling basic quality requirements
 - iii. not fulfilling the bitrate budget.

(10) The camera shall support scene adaptive bitrate control with one of the following capabilities to lower bandwidth and storage:

- Automatic dynamic Region of Interest to reduce bitrate in unprioritized regions in order to lowering bandwidth and storage requirements.
- Automatic dynamic Group of Pictures to lower bandwidth and storage requirements
- Automatic dynamic Frames per Second to lower bandwidth and storage requirements

(11) The camera shall support optimized image processing time for live streams by reducing the latency in live streams to the minimum.

d. Transmission

(1) The camera shall allow for video to be transported over:

- HTTP (Unicast)
- HTTPS (Unicast)
- RTP (Unicast & Multicast)
- RTP over RTSP (Unicast)
- RTP over RTSP over HTTP (Unicast)
- SRTP/RTSPS (Unicast & Multicast)

(2) The camera shall support Quality of Service (QoS) to be able to prioritize traffic.

e. Image

(1) The camera shall incorporate automatic and manual white balance.

(2) The camera shall incorporate an electronic shutter operating in the following ranges:

- WDR on: 1/8000 s to 2 s
- WDR off: 1/16000 to 2 s

- (3) The camera shall incorporate capture mode with the following settings:
 - 4K (3840x2160) with WDR: 12.5/15 fps (50/60 Hz)
- (4) The camera shall incorporate wide dynamic range – forensic WDR functionality.
- (5) The camera shall incorporate forensic wide dynamic range functionality providing up to 120 dB dynamic range.
- (6) The camera shall support manually defined values for:
 - Saturation
 - Brightness
 - Sharpness
 - Contrast
- (7) The camera shall incorporate a function for optimization of low-light behavior at different light levels.
- (8) The camera shall incorporate a function to manually correct barrel distortion, by using a slider to correct distortion in the image.
- (9) The camera shall allow for rotation of the image in steps of 90°.

f. Audio

- (1) The camera shall support two-way half and full duplex audio via network speaker pairing.
- (2) The camera shall support two-way audio connectivity via portcast technology with an accessory audio and I/O interface device.

g. IR Illumination

- (1) The camera shall be equipped with built-in IR LEDs with adjustable angle of illumination and intensity and with a range of up to 15 m (49.2 ft) with a wavelength of 850 nm.
- (2) The camera shall be equipped with built-in IR LEDs with automatic seamless adapting angle of illumination and intensity.

h. User Interface

- (1) Web server
 - The camera shall contain a built-in web server making video and configuration available to multiple clients in a standard operating system and browser environment using HTTP, without the need for additional software.

- Optional components downloaded from the camera for specific tasks shall be signed by an organization providing digital trust services.

(2) Language Specification

- The camera shall provide a function for altering the language of the user interface, and shall include support for at least 15 different languages.

(3) IP addresses

- The camera shall support both fixed IP addresses and dynamically assigned IP addresses provided by a Dynamic Host Control Protocol (DHCP) server.
- The camera shall allow for automatic detection of the camera based on UPnP and Bonjour when using a computer with an operating system supporting this feature.
- The camera shall provide support for both IPv4 and IPv6.
- The camera shall provide support for IPv6 USGv6.

i. PTZ functionality

(1) The camera shall:

- Provide optical zoom functionality:
 - i. Optical zoom: 2.5x

j. Event conditions

(1) The camera shall be equipped with an integrated event functionality:

- Device status
 - i. Operating temperature failure
 - ii. IP address
 - iii. Network lost
 - iv. System ready
 - v. Live stream
 - vi. Casing open
- Edge storage
 - i. Recording ongoing
 - ii. Storage disruption
 - iii. Storage health
- I/O
 - i. Manual trigger
 - ii. Virtual inputs
- MQTT

iii. Stateless

- Scheduled and recurring
- Video
 - i. Average bitrate degradation
 - ii. Day-night mode
 - iii. Tampering

(2) Response to triggers shall include event actions:

- Day-night mode
- Illumination: use lights, use lights while the rule is active
- MQTT: publish
- Notification: HTTP, HTTPS, TCP and email
- Overlay text
- Recordings: record, record while the rule is active
- SNMP traps: send, send while the rule is active
- Status LED: flash, flash while the rule is active
- Upload of images and video clips: FTP, SFTP, HTTP, HTTPS, network share, email.

(3) The camera shall provide memory for pre- and post-alarm recordings.

k. Storage

(1) The camera shall support continuous and event controlled recording to:

- Local memory added to the cameras microSD-card slot
- Network attached storage, located on the local network

(2) The camera shall incorporate encryption functionality for the SD card (AES-XTS-Plain64 256bit).

(3) The camera shall incorporate encryption functionality for the SD card.

(4) The camera shall be able to detect and notify edge storage disruptions.

l. Protocol

(1) The camera shall incorporate support for at least IPv4, IPv6 USGv6, ICMPv4/ICMPv6, HTTP, HTTPS, HTTP/2, TLS, QoS Layer 3 DiffServ, FTP, SFTP, CIFS/SMB, SMTP, mDNS (Bonjour), UPnP, SNMP v1/v2c/v3 (MIB-II), DNS/DNSv6,

DDNS, NTP, NTS, RTSP, RTP, SRTP/RTSPS, TCP, UDP, IGMPv1/v2/v3, RTCP, ICMP, DHCPv4/v6, ARP, SSH, LLDP, CDP, MQTT v3.1.1, Secure syslog (RFC 3164/5424, UDP/TCP/TLS), Link-Local address (ZeroConf), IEEE 802.1X (EAP-TLS), IEEE 802.1AR.

- (2) The SMTP implementation shall include support for SMTP authentication.

m. Text overlay

- (1) The camera shall:

- Provide embedded on-screen text with support for date & time, and a customer-specific text, camera name, of at least 45 ASCII characters.
- Provide the possibility to choose different font sizes for embedded on-screen text, and to use white or black text on at least four different backgrounds.
- Provide the ability to manually set up and configure privacy masks to the image.
- Allow for the overlay of a graphical image, such as a logotype, into the image.

n. Security

- (1) The camera shall support the following:

- Secure web browsing
 - i. The use of HTTPS and TLS, providing the ability to upload signed certificates to encrypt and secure authentication and communication of both administration data and video streams.
 - ii. Restrict access to the built-in web server by usernames and passwords at three different levels.
- Certificate management
 - i. Provide centralized certificate management, with both pre-installed CA certificates and the ability to upload additional CA certificates. The certificates shall be signed by an organization providing digital trust services.
- Enhanced security features
 - i. The collection of certificates (using IEEE 802.1AR) proves that the device and its firmware are authentic and produced by the

- manufacturer.
- ii. The product shall include a cryptographically verifiable hardware module where a collection of certificates, required to verify device identification, is installed.
 - iii. The product shall include a tamper-resistant hardware module. The module shall use a Trusted Execution Environment (TEE), providing a set of cryptographic features suitable for protecting private keys from unauthorized access.
 - iv. The product shall include a tamper-resistant hardware module, certified to at least Common Criteria EAL4+. The trusted platform module (TPM) shall provide a set of cryptographic features suitable for protecting private keys from unauthorized access. TPM is certified according to FIPS 140-2 level 2.
 - v. The product shall support for encrypted filesystem (AES-XTS-Plain64 256bit).
 - vi. The use of signed video (adding cryptographic checksum to H.264 videos signed by the manufacturer's secured device ID) provides support for validating the video's authenticity and origin.
 - vii. The use of signed firmware validates the firmware's integrity before accepting to install it.
 - viii. The use of a secure boot process, based on the use of signed firmware, ensures that the camera can boot only with authorized firmware.

- Authentication
 - i. IEEE 802.1x (EAP-TLS authentication).
 - ii. IEEE 802.1AE (MACsec PSK/EAP-TLS) authentication.
 - iii. Restrict access to pre-defined IP addresses via a host-based firewall.
- Brute force delay protection

(2) Firmware support

- The manufacturer should provide a Software Bill of Material (SBOM) for each product firmware in machine-readable format (CycloneDX, SPDX) that contains information about the software composition of the device's operating system, publicly available for

download.

- The manufacturer must provide firmware with long-term support that only contains corrections for critical bugs, security flaws and performance issues.
- The device should maintain high-level cybersecurity without introducing any significant functional changes or affecting any existing integrations.

o. System integration

- (1) The camera shall be fully supported by an open and published API (Application Programmers Interface), which shall provide necessary information for integration of functionality into third-party applications.
- (2) The camera shall be fully supported by the manufacturer's own application platform, including Native SDK and Computer vision SDK.
- (3) The camera shall conform to ONVIF profile G as defined by the ONVIF Organization.
- (4) The camera shall conform to ONVIF profile M as defined by the ONVIF Organization.
- (5) The camera shall conform to ONVIF profile S as defined by the ONVIF Organization.
- (6) The camera shall conform to ONVIF profile T as defined by the ONVIF Organization.

p. Analytics

- (1) The camera shall provide a platform allowing the upload of third-party applications into the camera.
- (2) The camera shall be equipped with a built-in, deep-learning processing unit capable of executing neural network algorithms, such as object detection, classification and segmentation (including vehicle types, license plates, people and faces). The deep-learning processing unit shall contain multiple parallel hardware accelerated compute resources capable of performing real-time video inference. The camera manufacturer shall support approved third-party developers to enable custom made deep-learning applications using the DLPU to accelerate custom trained deep-learning networks with commonly available network architectures.
- (3) The camera shall be supplied with preinstalled advanced video analytics capabilities, capable of detecting and classifying humans

and vehicles in non-critical indoor and outdoor spaces.

q. Installation and maintenance

- (1) The camera shall be supplied with Windows-based management software which allows the assignment of IP addresses, upgrade of firmware and backup of the cameras' configuration.
- (2) The camera shall support the use of SNMP-based management tools according to SNMP v1, 2c & 3 / MIB-II.
- (3) The camera shall allow updates of the software (firmware) over the network, using FTP or HTTP.
- (4) The camera shall store all customer-specific settings in a non-volatile memory that shall not be lost during power cuts or soft reset.
- (5) The camera shall provide the ability to apply a rectangle of customer-defined number of pixels to the image, which can be used as a pixel counter identifying the size of objects in number of pixels.
- (6) The camera shall accept external time synchronization from an NTP (Network Time Protocol) server.
- (7) The camera shall provide remote zoom and remote focus functionality.

r. Access log

- (1) The camera shall provide a log file, containing information about the 250 latest connections and access attempts since the unit's latest restart. The file shall include information about the connecting IP addresses and the time of connecting.
- (2) The camera shall provide a connection list of all currently connected viewers. The file shall include information about connecting IP address, time of connecting and the type of stream accessed.

s. Camera diagnostics

- (1) The camera shall be equipped with LEDs, capable of providing visible status information. LEDs shall indicate the camera's operational status and provide information about power, communication with receiver, the network status and the camera status.
- (2) The camera shall be monitored by a Watchdog functionality, which shall automatically re-initiate processes or restart the unit if

a malfunction is detected.

- (3) The camera shall send a notification when the unit has rebooted and all services are initialized.

t. Hardware interfaces

- (1) Network interface

- The camera shall be equipped with one 10BASE-T/100BASE-TX/1000BASE-T Ethernet-port using a RJ45 connector and shall support auto negotiation of network speed and transfer mode (full and half duplex).

- (2) Audio

- The camera shall provide audio connectivity via portcast technology with an accessory audio and I/O interface device.

u. Enclosure

- (1) The camera shall:

- Be manufactured with an IP66-, IP67-, NEMA 4X- and IK09-rated aluminum and plastic enclosure with a polycarbonate hard coated dome.

v. Power

- (1) The camera shall support power over Ethernet IEEE 802.3at Type 2 Class 4

- (2) IR illumination on

- Max: 25.50 W
- Typical: 14.98 W

- (3) IR illumination off

- Max: 14.70 W
- Typical: 8.92 W

w. Environmental

- (1) The camera shall:

- Operate in a temperature range of -30 °C to 50 °C (-22 °F to 122 °F)
- Operate in a maximum temperature (intermittent) of 74 °C (165 °F)
- Operate in a humidity range of 10–100% RH

(condensing).

- E. 7 MP panoramic camera with 180° coverage
1. The specified product shall meet or exceed the following design specifications:
 - a. The camera shall operate on an open source and Linux-based platform, and include a built-in web server.
 - b. The camera shall provide a removable IR-cut filter, providing day/night functionality.
 - c. The camera shall be equipped with a fixed 3.3 mm lens with a 7 MP image sensor with a horizontal field of view of 180° and a vertical field of view of 90°.
 - d. The camera shall provide local video storage utilizing a microSD/microSDHC/microSDXC memory card expansion.
 - e. The camera shall be manufactured with a repaintable metal (aluminum) casing.
 - f. The camera shall be manufactured with an IP66/IP67-, NEMA 4X- and IK10-rated enclosure fitted with a fixed weather shield.
 - g. The camera shall provide a manual 3-axis (pan/tilt/rotation) positioning to allow adjustment for optimum camera rotation and placement.
 2. The specified product shall meet or exceed the following performance specifications:
 - a. Illumination
 - (1) The camera shall meet or exceed the following illumination specifications:
 - Color: 0.15 lux at 50 IRE, F2.0
 - B/W: 0.05 lux at 50 IRE, F2.0
 - b. Resolution
 - (1) The camera shall be designed to provide video streams in 7 MP (3712x1856) at up to 30 frames per second (60Hz mode) or 25 frames per second (50Hz mode) using H.264, H265 or Motion JPEG.
 - (2) The camera shall provide 8 individually cropped out view areas.
 - (3) The camera shall support video resolutions including:
 - 2560x1440 (16:9)

- 3712x1856 (2:1)
- 2560x1280 (2:1)
- 1920x960 (2:1)

c. Video streaming

- (1) The camera shall provide independently configured H.264, H.265 and Motion JPEG streams.
- (2) The camera shall provide configurable compression levels.
- (3) The camera shall provide a video streaming indicator.
- (4) The camera shall support standard baseline profile with motion estimation.
- (5) The camera shall support motion estimation in H.264/MPEG-4 Part 10/AVC.
- (6) The camera shall support motion estimation in H.265 (MPEG-H Part 2/HEVC)
- (7) The camera shall support the following video encoding algorithms:
 - Motion JPEG encoding in a selectable range from 1 up to 25/30 frames per second.
 - Baseline Profile H.264 encoding with motion estimation in up to 25/30 frames per second.
 - Main Profile H.264 and H.265 encoding with motion estimation and context-adaptive binary arithmetic coding (CABAC) in up to 25/30 frames per second.
 - High Profile H.264 encoding with motion estimation up to 25/30 frames per second.
- (8) The camera shall in H.264 and H.265 support Variable Bit Rate (VBR), Average Bit Rate (ABR) and Maximum Bit Rate (MBR).
- (9) The camera shall be able to deliver predictable storage using Average Bit Rate (ABR) bitrate controlling algorithm based on a bitrate budget and selected retention time.
 - The camera shall be able to deliver predictable storage using Average Bit Rate (ABR) bitrate controlling algorithm based on a bitrate budget and the selected retention time.
 - i. The ABR bitrate algorithm, depending on the bitrate budget and the selected retention time, shall adjust the bitrate to meet the bitrate

budget over the whole retention time.

ii. The ABR algorithm shall have a method to keep the video quality even during busy periods by allowing the current bitrate to be significantly above the configured average bitrate during significant parts of the retention time.

- The camera shall in H.264 and H.265 support flexible retention period for Average Bit Rate (ABR) algorithm up to 1 year.
- When using Average Bit Rate (ABR) the camera shall keep bitrate history up to at least 30 days.
- The camera shall in H.264 and H.265 support reuse of past Average Bit Rate (ABR) history if a stream is disconnected and the camera reconnects with the same basic stream parameters.
- When using Average Bit Rate (ABR), the camera shall in H.264 and H.265 support multiple parallel stream with independent ABR-history.
- The camera shall issue bitrate degradation events when using Average Bit Rate (ABR) if the configuration is predicted to be
 - i. unrealistic
 - ii. not fulfilling basic quality requirements
 - iii. not fulfilling the bitrate budget.

(10) The camera shall support scene adaptive bitrate control with one of the following capabilities to lower bandwidth and storage:

- Automatic dynamic Region of Interest to reduce bitrate in unprioritized regions in order to lowering bandwidth and storage requirements.
- Automatic dynamic Group of Pictures to lower bandwidth and storage requirements
- Automatic dynamic Frames per Second to lower bandwidth and storage requirements

(11) The camera shall support optimized image processing time for live streams by reducing the latency in live streams to the minimum.

d. Transmission

(1) The camera shall allow for video to be transported over:

- HTTP (Unicast)
- HTTPS (Unicast)

- RTP (Unicast & Multicast)
- RTP over RTSP (Unicast)
- RTP over RTSP over HTTP (Unicast)
- SRTP/RTSPS (Unicast & Multicast)

(2) The camera shall support Quality of Service (QoS) to be able to prioritize traffic.

e. Image

(1) The camera shall incorporate automatic and manual white balance.

(2) The camera shall incorporate an electronic shutter operating in the range of 1/31500 s to 1.5 s.

(3) The camera shall incorporate capture mode with the following settings:

- 7 MP (3712x1856) with WDR: 25/30 fps (50/60 Hz)

(4) The camera shall incorporate wide dynamic range – forensic WDR functionality.

(5) The camera shall incorporate forensic wide dynamic range functionality providing up to 120 dB dynamic range.

(6) The camera shall support manually defined values for:

- Saturation
- Brightness
- Sharpness
- Contrast

(7) The camera shall support multiple scene profiles for:

- forensic
- vivid
- traffic overview
- backlit entrance

(8) The camera shall incorporate a function for optimization of low-light behavior at different light levels.

(9) The camera shall incorporate a function for motion-adaptive exposure to reduce motion blur from approaching or nearby object.

f. Audio

(1) The camera shall support configurable one-way and two-way simplex, half duplex and full duplex audio:

- Input sources
 - i. External unbalanced microphone, with an optional 5 V microphone power
 - ii. Digital input, with an optional 12 V ring power
 - iii. Unbalanced line input
- Output sources
 - i. Network speaker pairing

(2) Encoding

- The camera shall support:
 - i. 24bit LPCM
 - ii. AAC-LC 8/16/32/48 kHz
 - iii. G.711 PCM 8 kHz
 - iv. G.726 ADPCM 8 kHz
 - v. Opus 8/16/48 kHz
 - vi. Configurable bit rate

g. IR Illumination

(1) The camera shall be equipped with built-in IR LEDs, with a range of up to 15 m (50 ft) with a wavelength of 850 nm.

h. User Interface

(1) Web server

- The camera shall contain a built-in web server making video and configuration available to multiple clients in a standard operating system and browser environment using HTTP, without the need for additional software.
- Optional components downloaded from the camera for specific tasks shall be signed by an organization providing digital trust services.

(2) Language Specification

- The camera shall provide a function for altering the language of the user interface, and shall include support for at least 10 different languages.

(3) IP addresses

- The camera shall support both fixed IP addresses and dynamically assigned IP addresses provided by a

Dynamic Host Control Protocol (DHCP) server.

- The camera shall allow for automatic detection of the camera based on UPnP and Bonjour when using a computer with an operating system supporting this feature.
- The camera shall provide support for both IPv4 and IPv6.
- The camera shall provide support for IPv6 USGv6.

i. PTZ functionality

(1) The camera shall:

- Provide digital PTZ functionality.

j. Event conditions

(1) The camera shall be equipped with an integrated event functionality:

- Device status
 - i. Operating temperature failure
 - ii. Fan
 - iii. IP address
 - iv. Network lost
 - v. System ready
 - vi. Ring power
 - vii. Live stream
 - viii. Casing open
- Digital audio input status
- Edge storage
 - i. Recording ongoing
 - ii. Storage disruption
 - iii. Storage health
- I/O
 - i. Digital input
 - ii. Manual trigger
 - iii. Virtual inputs
- MQTT subscribe
- Scheduled and recurring
- Video
 - i. Average bitrate degradation
 - ii. Day-night mode
 - iii. Live stream
 - iv. Tampering

- (2) Response to triggers shall include event actions:
 - Audio clips: play, stop
 - Day and night mode
 - I/O: toggle I/O once, toggle I/O while the rule is active
 - MQTT: publish
 - Notification: HTTP, HTTPS, TCP and email
 - Overlay text
 - Recordings: SD card and network share
 - SNMP traps: send, send while the rule is active
 - Upload of images and video clips: FTP, SFTP, HTTP, HTTPS, email or network share
- (3) The camera shall provide memory for pre- and post-alarm recordings.

k. Storage

- (1) The camera shall support continuous and event controlled recording to:
 - Local memory added to the cameras microSD-card slot
 - Network attached storage, located on the local network
- (2) The camera shall incorporate encryption functionality for the SD card (AES-XTS-Plain64 256bit).
- (3) The camera shall incorporate encryption functionality for the SD card.
- (4) The camera shall be able to detect and notify edge storage disruptions.

l. Protocol

- (1) The camera shall incorporate support for at least IPv4, IPv6 USGv6, ICMPv4/ICMPv6, HTTP, HTTPS, HTTP/2, TLS, QoS Layer 3 DiffServ, FTP, SFTP, CIFS/SMB, SMTP, mDNS (Bonjour), UPnP, SNMP v1/v2c/v3 (MIB-II), DNS/DNSv6, DDNS, NTP, NTS, RTSP, RTP, SRTP, TCP, UDP, IGMPv1/v2/v3, RTCP, ICMP, DHCPv4/v6, ARP, SSH, LLDP, CDP, MQTT v3.1.1, Secure syslog (RFC 3164/5424, UDP/TCP/TLS), Link-Local address (ZeroConf), IEEE 802.1X (EAP-TLS), IEEE 802.1AR.
- (2) The SMTP implementation shall include support for SMTP authentication.

m. Text overlay

(1) The camera shall:

- Provide embedded on-screen text with support for date & time, and a customer-specific text, camera name, of at least 45 ASCII characters.
- Provide the possibility to choose different font sizes for embedded on-screen text, and to use white or black text on at least four different backgrounds.
- Provide the ability to manually set up and configure privacy masks to the image.
- Allow for the overlay of a graphical image, such as a logotype, into the image.

n. Security

(1) The camera shall support the following:

- Secure web browsing
 - i. The use of HTTPS and TLS, providing the ability to upload signed certificates to encrypt and secure authentication and communication of both administration data and video streams.
 - ii. Restrict access to the built-in web server by usernames and passwords at three different levels.
- Certificate management
 - i. Provide centralized certificate management, with both pre-installed CA certificates and the ability to upload additional CA certificates. The certificates shall be signed by an organization providing digital trust services.
- Enhanced security features
 - i. The use of signed firmware validates the firmware's integrity before accepting to install it.
 - ii. The use of a secure boot process, based on the use of signed firmware, ensures that the camera can boot only with authorized firmware.
 - iii. The use of signed video (adding cryptographic checksum to H.264 videos signed by the manufacturer's secured device ID) provides support for validating the

- video's authenticity and origin.
- iv. The use of trusted platform module (TPM) provides a set of cryptographic features suitable for protecting private keys from unauthorized access.
- v. TPM is certified according to FIPS 140-2 level 2.
- vi. The use of a cryptographically verifiable hardware module where a collection of certificates, required to verify device identification, is installed.
- vii. Support for encrypted filesystem (AES-XTS-Plain64 256bit).
- viii. The collection of certificates (using IEEE 802.1AR) proves that the device and its firmware are authentic and produced by the manufacturer.
- ix. The product shall include a tamper-resistant hardware module, certified to at least Common Criteria EAL4.

- Authentication
 - i. IEEE 802.1x (EAP-TLS, PEAP-MSCHAPv2) authentication.
 - ii. IEEE 802.1AE (MACsec PSK/EAP-TLS) authentication.
 - iii. Restrict access to pre-defined IP addresses via a host-based firewall.
- Brute force delay protection

(2) Firmware support

- The manufacturer should provide a Software Bill of Material (SBOM) for each product firmware in machine-readable format (CycloneDX, SPDX) that contains information about the software composition of the device's operating system, publicly available for download.
- The manufacturer must provide firmware with long-term support that only contains corrections for critical bugs, security flaws and performance issues.
- The device should maintain high-level cybersecurity without introducing any significant functional changes or affecting any existing integrations.

o. System integration

- (1) The camera shall be fully supported by an open and published API

(Application Programmers Interface), which shall provide necessary information for integration of functionality into third-party applications.

- (2) The camera shall be fully supported by the manufacturer's own application platform, including Native SDK and Computer vision SDK.
- (3) The camera shall conform to ONVIF profile G as defined by the ONVIF Organization.
- (4) The camera shall conform to ONVIF profile M as defined by the ONVIF Organization.
- (5) The camera shall conform to ONVIF profile S as defined by the ONVIF Organization.
- (6) The camera shall conform to ONVIF profile T as defined by the ONVIF Organization.

p. Analytics

- (1) The camera shall provide a platform allowing the upload of third-party applications into the camera.
- (2) The camera shall be equipped with a built-in, deep-learning processing unit capable of executing neural network algorithms, such as object detection, classification and segmentation (including vehicle types, license plates, people and faces). The deep-learning processing unit shall contain multiple parallel hardware accelerated compute resources capable of performing real-time video inference. The camera manufacturer shall support approved third-party developers to enable custom made deep-learning applications using the DLPU to accelerate custom trained deep-learning networks with commonly available network architectures.
- (3) The camera shall be supplied with preinstalled advanced video analytics capabilities, capable of detecting and classifying humans and vehicles in non-critical indoor and outdoor spaces.
 - The camera shall provide a function to measure how long an object (human or vehicle) stayed in a monitored area.

q. Installation and maintenance

- (1) The camera shall be supplied with Windows-based management software which allows the assignment of IP addresses, upgrade of firmware and backup of the cameras' configuration.
- (2) The camera shall support the use of SNMP-based management tools according to SNMP v1, 2c & 3 / MIB-II.

- (3) The camera shall allow updates of the software (firmware) over the network, using FTP or HTTP.
 - (4) The camera shall store all customer-specific settings in a non-volatile memory that shall not be lost during power cuts or soft reset.
 - (5) The camera shall provide the ability to apply a rectangle of customer-defined number of pixels to the image, which can be used as a pixel counter identifying the size of objects in number of pixels.
 - (6) The camera shall accept external time synchronization from an NTP (Network Time Protocol) server.
- r. Access log
- (1) The camera shall provide a log file, containing information about the 250 latest connections and access attempts since the unit's latest restart. The file shall include information about the connecting IP addresses and the time of connecting.
 - (2) The camera shall provide a connection list of all currently connected viewers. The file shall include information about connecting IP address, time of connecting and the type of stream accessed.
- s. Camera diagnostics
- (1) The camera shall be equipped with LEDs, capable of providing visible status information. LEDs shall indicate the camera's operational status and provide information about power, communication with receiver, the network status and the camera status.
 - (2) The camera shall be monitored by a Watchdog functionality, which shall automatically re-initiate processes or restart the unit if a malfunction is detected.
 - (3) The camera shall send a notification when the unit has rebooted and all services are initialized.
- t. Hardware interfaces
- (1) Network interface
 - The camera shall be equipped with one 10BASE-T/100BASE-TX/1000BASE-T Ethernet-port using a RJ45 connector and shall support auto negotiation of network speed and transfer mode (full and half duplex).
 - (2) Inputs/Outputs

- The camera shall be equipped with one digital (alarm) input and one digital output, accessible via a removable terminal block. This input shall be configurable to respond to normally open (NO) or normally closed (NC) dry contacts. The output shall be able to provide 12 V DC, 15 mA.

(3) Audio

- The camera shall be equipped with one 3.5 mm jack for line/mic input and one 3.5 mm jack for line output.

(4) Power

- The camera shall be equipped with a removable terminal block providing connectivity for external power.

u. Enclosure

(1) The camera shall:

- Be manufactured with an IP66/IP67-, NEMA 4X- and IK10-rated aluminum enclosure and a polycarbonate hard-coated dome.
- Be fitted with a fixed weather shield.

v. Power

(1) The camera shall support power over Ethernet IEEE 802.3af/802.3at Type 2 Class 4

- Max: 18 W
- Typical: 12 W

w. Environmental

(1) The camera shall:

- Operate in a temperature range of -40 °C to 55 °C (-40 °F to 131 °F)
- Operate in a maximum temperature (intermittent) of 74 °C (165 °F)
- Operate in a humidity range of 10–100% RH (condensing).

F. Fixed 5MP network dome camera with deep learning.

1. The specified product shall meet or exceed the following design specifications:

- a. The camera shall operate on an open source and Linux-based platform, and include a built-in web server.

- b. The camera shall provide a removable IR-cut filter, providing day/night functionality.
 - c. The camera shall be equipped with a 3–8 mm varifocal IR-corrected megapixel P-Iris lens with a 5 MP image sensor.
 - d. The camera shall be provide a horizontal field of view between 104° and 40° and a vertical field of view between 74° and 29° with a minimum focus distance of 1 m (3.2 ft).
 - e. The camera shall provide local video storage utilizing a microSD/microSDHC/microSDXC memory card expansion.
 - f. The camera shall be manufactured with a repaintable casing.
 - g. The camera shall be manufactured with an IP52- and IK10-rated polycarbonate hard coated dome and casing
 - h. The camera shall provide a manual 3-axis (pan/tilt/rotation) positioning to allow adjustment for optimum camera rotation and placement.
 - i. The camera shall provide options for clear and smoked lower dome.
2. The specified product shall meet or exceed the following performance specifications:
- a. Illumination
 - (1) The camera shall meet or exceed the following illumination specifications:
 - Color: 0.13 lux at 50 IRE, F1.3
 - B/W: 0 lux at 50 IRE, F1.3
 - b. Resolution
 - (1) The camera shall be designed to provide video streams in 5 MP (2592x1944) at up to 30 frames per second (60Hz mode) or 25 frames per second (50Hz mode) using H.264, H265 or Motion JPEG.
 - (2) The camera shall provide 2 individually cropped out view areas.
 - (3) The camera shall support video resolutions including:
 - 2592x1944 (5 MP, 4:3)
 - 1920x1080 (HDTV 1080p)
 - 1280x720 (HDTV 720p)
 - (4) The camera shall provide both landscape format (4:3 and 16:9 aspect ratio) as well as corridor format (3:4 and 9:16 aspect ratio).

c. Video streaming

- (1) The camera shall provide independently configured simultaneous H.264 and Motion JPEG streams.
- (2) The camera shall provide configurable compression levels.
- (3) The camera shall provide a video streaming indicator.
- (4) The camera shall support standard baseline profile with motion estimation.
- (5) The camera shall support motion estimation in H.264/MPEG-4 Part 10/AVC.
- (6) The camera shall support motion estimation in H.265 (MPEG-H Part 2/HEVC)
- (7) The camera shall support the following video encoding algorithms:
 - Motion JPEG encoding in a selectable range from 1 up to 25/30 frames per second.
 - Baseline Profile H.264 encoding with motion estimation in up to 25/30 frames per second.
 - Main Profile H.264 and H.265 encoding with motion estimation and context-adaptive binary arithmetic coding (CABAC) in up to 25/30 frames per second.
 - High Profile H.264 encoding with motion estimation up to 25/30 frames per second.
- (8) The camera shall in H.264 and H.265 support Variable Bit Rate (VBR), Average Bit Rate (ABR) and Maximum Bit Rate (MBR).
- (9) The camera shall be able to deliver predictable storage using Average Bit Rate (ABR) bitrate controlling algorithm based on a bitrate budget and selected retention time.
 - The camera shall be able to deliver predictable storage using Average Bit Rate (ABR) bitrate controlling algorithm based on a bitrate budget and the selected retention time.

The ABR bitrate algorithm, depending on the bitrate budget and the selected retention time, shall adjust the bitrate to meet the bitrate budget over the whole retention time.

The ABR algorithm shall have a method to keep the video quality even during busy periods by allowing the current bitrate to be significantly

above the configured average bitrate during significant parts of the retention time.

- The camera shall in H.264 and H.265 support flexible retention period for Average Bit Rate (ABR) algorithm up to 1 year.
- When using Average Bit Rate (ABR) the camera shall keep bitrate history up to at least 30 days.
- The camera shall in H.264 and H.265 support reuse of past Average Bit Rate (ABR) history if a stream is disconnected and the camera reconnects with the same basic stream parameters.
- When using Average Bit Rate (ABR), the camera shall in H.264 and H.265 support multiple parallel stream with independent ABR-history.
- The camera shall issue bitrate degradation events when using Average Bit Rate (ABR) if the configuration is predicted to be
 - unrealistic
 - not fulfilling basic quality requirements
 - not fulfilling the bitrate budget.

(10) The camera shall support scene adaptive bitrate control with one of the following capabilities to lower bandwidth and storage:

- Automatic dynamic Region of Interest to reduce bitrate in unprioritized regions in order to lowering bandwidth and storage requirements.
- Automatic dynamic Group of Pictures to lower bandwidth and storage requirements
- Automatic dynamic Frames per Second to lower bandwidth and storage requirements

(11) The camera shall support optimized image processing time for live streams by reducing the latency in live streams to the minimum.

d. Transmission

(1) The camera shall allow for video to be transported over:

- HTTP (Unicast)
- HTTPS (Unicast)
- RTP (Unicast & Multicast)
- RTP over RTSP (Unicast)
- RTP over RTSP over HTTP (Unicast)

- SRTP/RTSPS (Unicast & Multicast)
- (2) The camera shall support Quality of Service (QoS) to be able to prioritize traffic.
- e. Image
- (1) The camera shall incorporate automatic and manual white balance.
- (2) The camera shall incorporate an electronic shutter operating in the range of 1/33500 s to 1/5 s.
- (3) The camera shall incorporate capture mode with the following settings:
- HDTV 1080p (1920x1080) with WDR: 25/30 fps (50/60 Hz)
- (4) The camera shall incorporate wide dynamic range – forensic WDR functionality.
- (5) The camera shall incorporate forensic wide dynamic range functionality providing up to 120 dB dynamic range.
- (6) The camera shall support manually defined values for:
- Saturation
 - Brightness
 - Sharpness
 - Contrast
- (7) The camera shall incorporate a function for optimization of low-light behavior at different light levels.
- (8) The camera shall incorporate a function to manually correct barrel distortion, by using a slider to correct distortion in the image.
- (9) The camera shall allow for rotation of the image in steps of 90°.
- (10) The camera shall incorporate automatic defog functionality.
- f. Audio
- (1) The camera shall support two-way audio connectivity via edge-to-edge technology and network speaking pairing:
- Input sources
 - External microphone
 - External line device

Ring power technology (with selected microphone models)

- Output sources
 - Automatic gain control
 - Network speaker pairing

(2) Encoding

- The camera shall support:
 - 24bit LPCM
 - AAC-LC 8/16/32/44.1/48 kHz
 - G.711 PCM 8 kHz
 - G.726 ADPCM 8 kHz
 - Opus 8/16/48 kHz
 - Configurable bit rate

g. IR Illumination

- (1) The camera shall be equipped with built-in IR LEDs, with a range of up to 40 m (130 ft) with a wavelength of 850 nm.
- (2) The camera shall be equipped with built-in IR LEDs with automatic seamless adapting angle of illumination and intensity.

h. User Interface

(1) Web server

- The camera shall contain a built-in web server making video and configuration available to multiple clients in a standard operating system and browser environment using HTTP, without the need for additional software.
- Optional components downloaded from the camera for specific tasks shall be signed by an organization providing digital trust services.

(2) Language Specification

- The camera shall provide a function for altering the language of the user interface, and shall include support for at least 10 different languages.

(3) IP addresses

- The camera shall support both fixed IP addresses and dynamically assigned IP addresses provided by a Dynamic Host Control Protocol (DHCP) server.
- The camera shall allow for automatic detection of the camera based on UPnP and Bonjour when using a

computer with an operating system supporting this feature.

- The camera shall provide support for both IPv4 and IPv6.
- The camera shall provide support for IPv6 USGv6.

i. PTZ functionality

(1) The camera shall:

- Provide digital PTZ functionality.
- Provide preset positions functionality.
- Provide a guard tour functionality which allows the dome to automatically move between selected presets using an individual speed and viewing time for each preset.

j. Event conditions

(1) The camera shall be equipped with an integrated event functionality:

- Analytics
 - External input
 - Supervised external input
 - Virtual inputs through API
- Audio
 - Audio detection
- Call
 - State
 - State change
- Device status
 - Operating temperature failure
 - IP address
 - Network lost
 - System ready
 - Ring power overcurrent protection
 - Live stream active
 - Casing open
- Digital audio
 - Digital signal
- Edge storage
 - Recording ongoing
 - Storage disruption
 - Storage health

- I/O
 - Digital input
 - Manual trigger
 - Virtual inputs
- MQTT
 - Subscribe
- Scheduled and recurring
- Video
 - Average bitrate degradation
 - Day-night mode
 - Live stream open
 - Tampering

(2) Response to triggers shall include event actions:

- Record video: SD card and network share
- Upload of images and video clips: FTP, SFTP, HTTP, HTTPS, email or network share
- Send notification: email, HTTP, HTTPS, TCP and SNMP trap
- Pre- and post-alarm video or image buffering for recording or upload
- I/O: toggle I/O once, toggle I/O while the rule is active.
- MQTT: publish
- Overlay text
- External output activation
- Zoom preset
- Day and night mode
- Flash status LED
- Use lights
- Set defog mode
- Set WDR mode

(3) The camera shall provide memory for pre- and post-alarm recordings.

k. Storage

(1) The camera shall support continuous and event controlled recording to:

- Local memory added to the cameras microSD-card slot
 - Network attached storage, located on the local network
- (2) The camera shall incorporate encryption functionality for the SD card (AES-XTS-Plain64 256bit).
 - (3) The camera shall incorporate encryption functionality for the SD card.
 - (4) The camera shall be able to detect and notify edge storage disruptions.

l. Protocol

- (1) The camera shall incorporate support for at least IPv4, IPv6 USGv6, ICMPv4/ICMPv6, HTTP, HTTPS, HTTP/2, TLS, QoS Layer 3 DiffServ, FTP, SFTP, CIFS/SMB, SMTP, mDNS (Bonjour), UPnP, SNMP v1/v2c/v3 (MIB-II), DNS/DNSv6, DDNS, NTP, NTS, RTSP, RTCP, RTP, SRTP/RTSPS, TCP, UDP, IGMPv1/v2/v3, DHCPv4/v6, ARP, SSH, SIP, LLDP, CDP, MQTT v3.1.1, Secure syslog (RFC 3164/5424, UDP/TCP/TLS), Link-Local address (ZeroConf).
- (2) The SMTP implementation shall include support for SMTP authentication.

m. Text overlay

- (1) The camera shall:
 - Provide embedded on-screen text with support for date & time, and a customer-specific text, camera name, of at least 45 ASCII characters.
 - Provide the possibility to choose different font sizes for embedded on-screen text, and to use white or black text on at least four different backgrounds.
 - Provide the ability to manually set up and configure privacy masks to the image.
 - Allow for the overlay of a graphical image, such as a logotype, into the image.

n. Security

- (1) The camera shall support the following:
 - Secure web browsing
The use of HTTPS and TLS, providing the ability to upload signed certificates to encrypt and secure authentication and communication of both administration data and video streams.

Restrict access to the built-in web server by usernames and passwords at three different levels.

- Certificate management
Provide centralized certificate management, with both pre-installed CA certificates and the ability to upload additional CA certificates. The certificates shall be signed by an organization providing digital trust services.
- Enhanced security features
The use of signed firmware validates the firmware's integrity before accepting to install it.
The use of a secure boot process, based on the use of signed firmware, ensures that the camera can boot only with authorized firmware.
The use of a cryptographically verifiable hardware module where a collection of certificates, required to verify device identification, is installed.
Support for encrypted filesystem (AES-XTS-Plain64 256bit).
The product shall include a tamper-resistant hardware module, certified to at least Common Criteria EAL6+. The module shall use a Trusted Execution Environment (TEE), providing a set of cryptographic features suitable for protecting private keys from unauthorized access.
- Authentication
IEEE 802.1x (EAP-TLS, PEAP-MSCHAPv2) authentication.
IEEE 802.1AE (MACsec PSK/EAP-TLS) authentication.
Restrict access to pre-defined IP addresses via a host-based firewall.
- Brute force delay protection

(2) Firmware support

- The manufacturer should provide a Software Bill of Material (SBOM) for each product firmware in machine-readable format (CycloneDX, SPDX) that contains information about the software composition of the device's operating system, publicly available for download.

- The manufacturer must provide firmware with long-term support that only contains corrections for critical bugs, security flaws and performance issues.
- The device should maintain high-level cybersecurity without introducing any significant functional changes or affecting any existing integrations.

o. System integration

- (1) The camera shall be fully supported by an open and published API (Application Programmers Interface), which shall provide necessary information for integration of functionality into third-party applications.
- (2) The camera shall conform to ONVIF profile G as defined by the ONVIF Organization.
- (3) The camera shall conform to ONVIF profile M as defined by the ONVIF Organization.
- (4) The camera shall conform to ONVIF profile S as defined by the ONVIF Organization.
- (5) The camera shall conform to ONVIF profile T as defined by the ONVIF Organization.
- (6) Support for Session Initiation Protocol (SIP) for integration with Voice over IP (VoIP) systems, peer to peer or integrated with SIP/PBX

p. Analytics

- (1) The camera shall provide a platform allowing the upload of third-party applications into the camera.
- (2) The camera shall be equipped with a built-in, deep-learning processing unit capable of executing neural network algorithms, such as object detection, classification and segmentation (including vehicle types, license plates, people and faces). The deep-learning processing unit shall contain multiple parallel hardware accelerated compute recourses capable of performing real-time video inference. The camera manufacturer shall support approved third-party developers to enable custom made deep-learning applications using the DLPU to accelerate custom trained deep-learning networks with commonly available network architectures.
- (3) The camera shall be supplied with preinstalled advanced video analytics capabilities, capable of detecting and classifying humans and vehicles in non-critical indoor and outdoor spaces.

- The camera shall provide a function to measure how long an object (human or vehicle) stayed in a monitored area.

q. Installation and maintenance

- (1) The camera shall be supplied with Windows-based management software which allows the assignment of IP addresses, upgrade of firmware and backup of the cameras' configuration.
- (2) The camera shall support the use of SNMP-based management tools according to SNMP v1, 2c & 3 / MIB-II.
- (3) The camera shall allow updates of the software (firmware) over the network, using FTP or HTTP.
- (4) The camera shall store all customer-specific settings in a non-volatile memory that shall not be lost during power cuts or soft reset.
- (5) The camera shall provide the ability to apply a rectangle of customer-defined number of pixels to the image, which can be used as a pixel counter identifying the size of objects in number of pixels.
- (6) The camera shall accept external time synchronization from an NTP (Network Time Protocol) server.
- (7) The camera shall provide remote zoom and remote focus functionality.

r. Access log

- (1) The camera shall provide a log file, containing information about the 250 latest connections and access attempts since the unit's latest restart. The file shall include information about the connecting IP addresses and the time of connecting.
- (2) The camera shall provide a connection list of all currently connected viewers. The file shall include information about connecting IP address, time of connecting and the type of stream accessed.

s. Camera diagnostics

- (1) The camera shall be equipped with LEDs, capable of providing visible status information. LEDs shall indicate the camera's operational status and provide information about power, communication with receiver, the network status and the camera status.
- (2) The camera shall be monitored by a Watchdog functionality,

which shall automatically re-initiate processes or restart the unit if a malfunction is detected.

- (3) The camera shall send a notification when the unit has rebooted and all services are initialized.

t. Hardware interfaces

- (1) Network interface

- The camera shall be equipped with one 10BASE-T/100BASE-TX Ethernet-port using a RJ45 connector and shall support auto negotiation of network speed (100 MBit/s and 10 MBit/s) and transfer mode (full and half duplex).

- (2) Inputs/Outputs

- The camera shall be equipped with one digital (alarm) input and one digital output, accessible via a removable terminal block. This input shall be configurable to respond to normally open (NO) or normally closed (NC) dry contacts. The output shall be able to provide 12 V DC, 25 mA.

- (3) Audio

- The camera shall be equipped with one 3.5 mm jack for line/mic input and one 3.5 mm jack for line output.

- (4) Power

- The camera shall be equipped with a removable terminal block providing connectivity for external power.

u. Enclosure

- (1) The camera shall:

- Be manufactured with an IP52- and IK10-rated polycarbonate hard coated dome and polycarbonate casing.

v. Power

- (1) The camera shall provide power over Ethernet IEEE 802.3af/802.3at Type 1 Class 3

- Max: 9 W
- Typical: 6.4 W

w. Environmental

- (1) The camera shall:

- Operate in a temperature range of 0 °C to 50 °C (32 °F to 122 °F)
- Operate in a humidity range of 10–85% RH (non-condensing).

PART 3 - EXECUTION

3.01 INSTALLATION

- A. The contractor's or subcontractor's main resources within the project shall carry proper professional certification issued by the manufacturer and verified by a third-party organization to confirm sufficient product and technology knowledge.
- B. The contractor shall carefully follow instructions in documentation provided by the manufacturer to ensure all steps have been taken to provide a reliable, easy-to-operate system.
- C. All equipment shall be tested and configured in accordance with instructions provided by the manufacturer prior to installation.
- D. All firmware found in products shall be the latest and most up-to-date version as specified by the manufacturer, or by the product component provider.
- E. All equipment requiring users to log on using a password shall be configured with user/site-specific password/passwords. No system/product default passwords shall be allowed.
- F. A proper installation shall meet NEC (National Electrical Code – US only) per the guidelines of that year's revision. When properly installed equipment meets Low Voltage, Class 2 classification of the NEC.

END OF SECTION 28 21 13

SECTION 28 23 00
VIDEO MANAGEMENT SYSTEM

PART 1 - GENERAL

1.01 SYSTEM

- A. Section 28 13 00 – Electronic Access Control System

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00:

- 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) Requirements.

1.03 DEFINITIONS

- A. ACS – Access Control System
- B. CSA – Client Software Application
- C. DGM – Dynamic Graphical Maps
- D. DVS – Digital Video Server
- E. ALPR – Automatic License Plate Recognition
- F. SDK – Software Development Kit
- G. SSM – Server Software Module
- H. UI – User Interface
- I. USP – Unified Security Platform
- J. UWI - Unified Web Interface
- K. VMS – Video Management System

1.04 QUALIFICATIONS

- A. The system programmer shall have attended manufacturer training and obtained certification.
- B. The system programmer shall be a partner with the following level of qualification:
 - 1. Certified Reseller or up
 - 2. Elite Reseller or up

3. Unified Elite Reseller

- C. The system programmer shall submit proof of certifications.

PART 2 - PRODUCTS

2.01 VMS GENERAL REQUIREMENTS

- A. The VMS shall support updating its camera drivers independent from the VMS installation. New drivers shall be released multiple times a year to extend support for new devices and features.
- B. The VMS shall be based on a true open architecture that shall allow the use of non-proprietary workstation and server hardware, non-proprietary network infrastructure, and non-proprietary storage.
- C. The VMS shall offer a complete and scalable video surveillance solution that shall allow cameras to be added on a unit-by-unit basis.
- D. The VMS shall interface with analog-to-digital video encoders and IP cameras and with digital-to-analog video decoders, hereafter referred to as digital video servers (DVS). The VMS shall support DVS from various manufacturers.
- E. The VMS shall integrate DVS using the DVS native SDK or using the following industry standards to interface to the DVS:
1. ONVIF
- F. All video streams supplied from analog cameras or IP cameras shall be digitally encoded in H.265, H.264, MPEG-4, MPEG-2, MJPEG, MxPEG, Wavelet, or JPEG2000 compression formats and recorded simultaneously in real time.
- G. All audio streams supplied from IP video servers shall be digitally encoded in g711 (u-law), g721, g723, or AAC compression formats and recorded simultaneously in real time.
- H. Each camera's bit rate, frame rate, and resolution shall be set independently from other cameras in the system and altering these settings shall not affect the recording and display settings of other cameras.
- I. The VMS shall be able to use multiple CCTV keyboards to operate the entire set of cameras throughout the system, including brands of cameras from various manufacturers and including their PTZ functionalities (i.e., Pelco keyboard controls Panasonic dome or vice-versa).
- J. The VMS shall be able to retrieve and set the current position of PTZ cameras using XYZ coordinates.
- K. The VMS shall support PTZ camera protocols from multiple manufacturers, including analog and IP protocols.
- L. The VMS shall arbitrate the user conflict on PTZ usage based on user levels per camera.

- M. The VMS shall support changing passwords of video units.
1. The VMS shall show the strength of the current unit password.
 2. The VMS shall have the ability to change the password manually or using a string password generator for single or multiple units.
 3. The VMS shall have the ability to automatically update passwords on schedule.
 4. The VMS shall keep the history for passwords and the ability to retrieve them.
 5. The VMS shall have the ability to export passwords of units for safekeeping.
- N. The VMS shall support managing certificates of video units used for secure command and control (HTTPS and RTSPS):
1. Push Initial Certificate
 2. Automatically switch from HTTP and RTSP to HTTPS and RTSPS
 3. Allow certificate renewal
 4. Manage certificates manually for a single device or a batch of devices
 5. Automatically update upon configured schedule for single device or batch of devices
- O. The VMS shall allow for the configuration of a time zone for each camera connected to a DVS. For playback review, users shall have the ability to search for video based on the following options:
1. Local time of the camera
 2. Local time of the SSM
 3. Local time of user's workstation
- P. Audio and Video storage configuration for the SSM shall either be:
1. Internal or external IDE/SATA/SAS organized or not in a RAID configuration.
 2. Internal or external SCSI/iSCSI/Fiber Channel organized or not in a RAID configuration.
 3. Within the overall storage system, it shall be possible to include disks located on:
 - a. External PCs on a LAN or WAN
 - b. Network Attached Servers (NAS) on a LAN or WAN
 - c. Storage Area Networks (SAN)

Q. The SSM shall not limit the actual storage capacity configured per server.

2.02 CYBER SECURITY REQUIREMENTS

- A. The USP shall be an IP enabled solution. All communication between the SSM and CSA shall be based on standard TCP/IP protocol and shall use TLS encryption with digital certificates to secure the communication channel.
- B. The USP shall support user authentication with claims-based authentication using external providers. External providers shall include:
1. ADFS (Active Directory Federation Services)
 2. Azure Active Directory (through OpenID Connect)
 3. Ping Identity (through OpenID Connect)
 4. KeyCloak (through OpenID Connect)
 5. Other Open ID Connect / SAML2 authentication agents
- C. The USP shall limit the IP ports in use and shall provide the Administrator with the ability to configure these ports.
- D. The VMS shall support only secured media stream requests, unless explicitly configured otherwise. Secured media stream requests shall be secured with strong certificate-based authentication leveraging RTSPS (RTSP over TLS). Client authentication for media stream requests is claims-based and may use a limited lifetime security token.
- E. The VMS shall offer the ability to encrypt the media stream, including video, audio, and metadata with authenticated encryption. Media stream encryption shall be done at rest and in transit and be a certificate-based AES 128-bits encryption. The VMS shall:
1. Allow encryption to be set on a per camera basis for all or some of the cameras.
 2. Provide up to 20 different certificates for different groups of CSA or users who have been granted access to decrypted streams.
 3. Not decrease the recording performance by more than 50% when encryption is enabled.
 4. Use Secure RTP (SRTP) to encrypt the payload of a media stream in transit and allow multicast and unicast of the encrypted stream.
 5. Use a random encryption key and change periodically.
 6. Allow encrypted streams to be exported.
- F. The VMS shall support end to end encrypted streams with cameras supporting Secure RTP (SRTP) both in unicast and multicast from the camera.
- G. The USP shall support encryption for all communications with its databases.

- H. The USP shall provide in its main user interface a visual list showing the state of all configuration items relating to the cyber security hardening of the features of the system.
- I. The USP shall provide recommendations relating to the passwords used to access the hardware units in the system. The recommendation should display if the passwords used on the units are weak, average, strong, or very strong.
- J. The USP shall provide the ability to manually or automatically change the video unit passwords with manufacturer's native API, standard Genetec Protocol or ONVIF. The VMS shall support password change for video units as follows:
 - 1. In batch or per unit
 - 2. On schedule
 - 3. From an event
 - 4. Based on manufacturer's policies
 - 5. The USP shall allow backup of last 5 passwords.
 - 6. The USP shall allow copying password to clipboard to be used in the device webpage if the user has the appropriate privileges.
 - 7. The USP shall provide the ability to export the video unit passwords if the user has the appropriate privileges.
- K. The USP shall provide recommendations relating to the firmware of the hardware units enrolled in the system. Recommendations should display if the firmware is up to date, out of date, or if it has known security vulnerabilities.

2.03 FAILOVER AND STANDBY REQUIREMENTS

- A. The USP shall support native and off-the-shelf failover options.
- B. Failover Directory:
 - 1. The Standby Directory shall act as a replacement SSM on hot standby, ready to take over as the acting Directory in case the primary Directory fails. The failover shall occur in less than one minute. No action from the user shall be required.
 - 2. The USP shall support up to five (5) Directories on standby, lined up to take over as the acting Directory in a cascading fashion.
 - 3. The Standby Directory shall keep its configuration database synchronized with the primary Directory.
 - 4. The Standby Directory shall support disaster recovery scenarios where a server can be located in another geographic area (or building) and only take over if all other Directories become offline.
 - 5. The Standby Directory shall support synchronization of the configuration

databases using a backup and restore mechanism. The synchronization period shall be configurable from 15 minutes to 1 week.

6. The Standby Directory shall support real-time synchronization of the configuration databases using SQL Mirroring or SQL Always On.

C. Standby Archiver. Refer to section 2.05 Standby Archiver for more information.

2.04 ARCHIVING

A. The Archiver (role) shall use an event and timestamp database for the advanced search of audio/video archives. This database shall use Microsoft SQL.

B. The Archiver shall protect archived audio/video files and the system database against network access and non-administrative user access.

C. The Archiver shall digitally sign recorded video using an EdDSA signature algorithm based on a public/private key cryptography.

D. The Archiver shall offer a plug and play type hardware discovery service with the following functionalities:

1. Automatically discover DVS units as they are attached to the network.

2. Discover DVS units on different network segments, including the Internet, and across routers with or without network address translation (NAT) capabilities.

E. The Archiver shall have the capacity to configure the key frame interval (I-frame) in seconds or number of frames.

F. The Archiver shall provide a pre-alarm and post-alarm recording option that can be set between one second and 5 minutes on a per camera basis.

G. The Archiver shall provide the functionality of storing of video and audio streams based on triggering events, such as:

1. Digital motion detection

2. Digital input activation

3. Macros

4. Through SDK application recording

H. The Archiver shall perform video motion detection on each individual camera based on a grid of 1320 motion detection blocks. All of the video motion detection settings are configurable on schedule. A global sensitivity threshold is available to reduce motion detection sensitivity when the video signal is noisy or when a lot of false hits are incurred. Video motion detection itself can be set into four different modes:

1. Full Screen: All 1320 blocks on screen are activated, and a general threshold for the overall motion in the entire image can be set, and when it is reached, it can

trigger recording and a motion event or a custom event.

2. Full Screen Unit: This is the same as the Full Screen, but the motion detection takes place in the DVS.
 3. Detection Zone: Six overlapping zones can be defined in the 1320 blocks on screen with each of these zones having its own threshold, and, when that threshold is reached, each one of them can trigger recording and a motion event or a custom event. Each zone triggering its own event allows for the configuration of directional motion detection events and other complex motion detection logic.
 4. Detection Zone Unit: This is the same as the Detection Zone, but the motion detection takes place in the DVS and only one zone is supported.
 5. Disabled: No motion detection is performed on this camera.
- I. The Archiver shall be able to detect motion in video within 200 milliseconds and not only on key frames.
 - J. The Archiver shall allow for multiple recording schedules to be assigned to a single camera. Each schedule shall be created with the following parameters:
 1. Recording mode:
 - a. Continuous
 - b. On Motion/Manual
 - c. Manual
 - d. Disabled
 2. Recurrence pattern:
 - a. Once on specific days
 - b. Specific days on a yearly basis
 - c. Specific days on a monthly basis
 - d. Specific days on a weekly basis
 - e. Daily
 - K. Time coverage:
 - a. All day.
 - b. Specific time range(s).
 - c. Daytime or nighttime based on the times of sunrise and sunset that are automatically calculated from the time of year and a geographical location.

Provision shall be given to offset the calculated sunrise or sunset time by plus or minus 3 hours.

- L. The Archiver shall allow each camera (video source) to be encoded multiple times in the same or different video formats (H.265, H.264, MPEG-4, MPEG-2, MJPEG, MxPEG, Wavelet, or JPEG2000), limited only by the capabilities of each DVS.
- M. Whenever multiple video streams are available from the same camera, users shall be free to use any one of them based on their assigned usage. The standard video stream usages are:
 - 1. Live
 - 2. Recording
 - 3. Remote
 - 4. Low resolution
 - 5. High resolution
- N. The Archiver shall allow the video quality to vary according to predefined schedules. Such schedules shall have the same configuration flexibility as the recording schedules mentioned earlier. The video quality shall be based on, but not limited to, the following parameters:
 - 1. Maximum bit rate
 - 2. Maximum frame rate
 - 3. Image quality
 - 4. Key frame interval
- O. The Archiver shall have the ability to dynamically boost the quality of the "recording stream" (see previous bullet) based on specific events:
 - 1. When recording is started manually by a user.
 - 2. When recording is triggered by a macro, an alarm or detected motion.
- P. The Archiver shall have the capacity to communicate with the DVS using 128 bits SSL encryption.
- Q. The Archiver shall have the capacity to communicate with the DVS using HTTPS secure protocol.
- R. The Archiver shall have the capacity to receive multicast UDP streams directly from the DVS.
- S. For network topologies that restrict the DVS from sending multicast UDP streams, the Archiver shall redirect audio/video streams to active viewing clients on the network using

multicast UDP.

- T. The Archiver shall have the capacity to redirect audio/video streams to active viewing clients on the network using unicast UDP or TCP.
- U. The Archiver shall empower the administrator with a full range of disk management options:
 - 1. The Archiver shall allow the administrator to choose which disks to use for archiving and to set a maximum quota for each.
 - 2. The Archiver shall allow the administrator to spread the archiving of different cameras on different disk groups (groups of disks controlled by the same controller) so that archiving could be carried out in parallel on multiple disks.
 - 3. The Archiver shall have the capacity to move video archives to the Azure Cloud. The archives will be moved after a preset number of days.
- V. The Archiver shall empower the administrator with a full range of archive management options:
 - 1. The Archiver shall provide a graphical representation of video sequences and recording gaps.
 - 2. The Archiver shall provide the percentage of available video displayed over the queried time range.
 - 3. The Archiver shall provide a way to identify the location of the video sequences.
- W. The Archiver shall offer the following options to clean up old archives, on a camera-by-camera basis:
 - 1. After a preset number of days.
 - 2. Deleting oldest archives first when disks run out of space.
 - 3. Stop archiving when disks are full.
- X. The Archiver shall allow important video sequences to be protected against normal disk cleanup routines.
- Y. Users shall have the following options when protecting a video sequence:
 - 1. Until a specified date
 - 2. For a specified number of days
 - 3. Indefinitely (until the protection is explicitly removed)
- Z. The Archiver shall allow the administrator to put a cap on the percentage of storage space occupied by protected video.

- AA. The Archiver shall keep a log and compile statistics on disk space usage.
1. The statistics shall be available by disk group or for the whole Archiver.
 2. The statistics shall show the percentage of protected video over the total used disk space.
- BB. The Archiver shall have the capacity to down-sample video streams for storage saving purposes. The down-sampling options available are the following:
1. For H.264, MPEG-4, and H.265, streams the down-sampling options are: all key frames, 1 fps, 2 sec./frame, 5 sec./frame, 10 sec./frame, 15 sec./frame, 30 sec./frame, 60 sec./frame, 120 sec./frame.
 2. For MJPEG streams the down-sampling options are: 15 fps, 10 fps, 5 fps, 2 fps, 1 fps, 2 sec./frame, 5 sec./frame, 10 sec./frame, 15 sec./frame, 30 sec./frame, 60 sec./frame, 120 sec./frame.
- CC. The Archiver shall support DVS with edge recording capabilities and offer the following capacity:
1. The ability to playback the video recorded on the DVS at different speeds.
 2. The ability to offload (video trickling) the video recorded on the DVS on schedule, on event, or manually to store it on the Archiver.
 3. It shall be possible to filter the video that is being offloaded using one or multiple of the following filters:
 - a. Time interval
 - b. Playback request
 - c. Video analytic events
 - d. Motion events
 - e. Bookmarks
 - f. Alarms
 - g. Input pin events
 - h. Unit offline events
- DD. The Archiver shall provide the ability to encrypt the media stream coming from the DVS including the video, audio and metadata:
1. Media encryption shall be optional and can be activated on a per DVS basis.
 2. Media encryption shall be performed with AES 128-bits.

3. Media encryption shall encrypt all video, audio and metadata at rest and in transit. Once media encryption is turned on for a DVS, all media stored or redirected by the Archiver shall be encrypted and shall require the private key to be decoded.
4. It shall be possible to export the encrypted media into a non-encrypted ASF file.

2.05 CLOUD ARCHIVING

- A. The VMS shall support the automatic transfer of video recorded on the Archiver to the cloud, based on the age of the video.
- B. The Archiver shall encrypt recordings using AES-256 prior to transferring video to the cloud.
- C. The Archiver shall rotate the encryption key at every file. The encryption key shall be encrypted with a certificate kept in Azure Key Vault.
- D. The VMS shall support TLS encryption between the on-premises Archiver and the cloud.
- E. The VMS shall allow users to search video stored in the cloud through the same functionality used when querying video that is stored locally.
- F. The VMS will maintain a local cache of video downloaded from the cloud to playback recordings without requiring an additional transfer.
- G. The VMS shall support different tiers to support the video sequences.
 1. The VSM shall allow users to differentiate the video sequences available for real-time and delayed retrieval.
 2. The VMS shall automatically move video sequences from the real-time access to delayed retrieval after a configurable delay.

2.06 VMS MEDIA STREAMING

- A. The Media Router Role shall be responsible for routing video and audio streams across local and wide area networks from the source (for example DVS) to the destination (for example CSA).
- B. The Media Router Role shall support multiple transport protocols, such as unicast TCP, unicast UDP, and multicast UDP.
- C. The Media Router shall support IGMP (Internet Group Management Protocol) to establish multicast group memberships:
 1. IGMP v3, including SSM (Source-Specific Multicast) shall be supported.
- D. The Media Router Role using Redirector Agents shall be responsible for redirecting a stream from a source IP endpoint to a destination IP endpoint.
- E. The Redirector Agents shall be capable of converting a stream from and to any supported transport protocols:

1. Multicast UDP to Unicast TCP
 2. Multicast UDP to Unicast UDP
 3. Unicast TCP to Multicast UDP
 4. Unicast UDP to Multicast UDP
- F. It shall be possible to limit the number of concurrent live and playback video redirections for each Redirector Agent in order to better control the bandwidth across multiple sites.
- G. It shall be possible to limit the bandwidth consumed by live and playback video from the CSA to better control the bandwidth across multiple sites. The SSM shall be able to prioritize video streaming to the CSA based on user level.
- H. It shall be possible to protect the Media Router Role against hardware or software unavailability by configuring another Media Router Role to act as a hot standby server.
- I. Multiple Redirector Agents shall be used on a large VMS installation to increase the service availability and to provide automatic load balancing.

2.07 VMS VIDEO ARCHIVES TRANSFER CAPABILITIES

- A. Archive transfer shall provide the ability to:
1. Transfer video from a server to another server in the same system.
 2. Transfer video from a federated server to another server.
 3. Transfer video from camera storage to a server.
- B. It shall be possible to program video transfers either on a recurrent schedule, or to trigger them manually or upon connection.
- C. It shall be possible to filter the video of interest for a transfer. The video of interest shall be defined with the following filters:
1. All archives when the camera was offline.
 2. Alarms.
 3. Playback request from the edge.
 4. Video analytics events.
 5. Motion events.
 6. Bookmarks.
 7. Input triggers.
 8. Time range.

- D. It shall be possible to define the length of video before and after the event used as a filter to determine the video of interest.
- E. The USP shall offer an interface for displaying all video archive transfer requests. This interface shall display all the current, requested and scheduled video transfer requests. It shall be possible to edit, trigger, and cancel video archive transfers from this interface.
- F. The USP shall offer an interface for querying past video transfers and their outcome.

2.08 SECURITY VIDEO ANALYTICS

- A. The analytics shall be completely unified with the Video Management System.
- B. Configuration shall natively be performed in the configuration interface of the Video Management System.
- C. The analytics shall feature dedicated configuration possibilities for the following scenarios:
 - 1. Perimeter protection
 - 2. Positional tracking
 - 3. Area protection
 - 4. Direction control
 - 5. Object detection
 - 6. Stopped vehicle detection
 - 7. Tailgating Detection
- D. Each of the scenarios shall trigger events in the Video Management System, which correspond to their functionality.
- E. Additional to these scenarios, the analytics shall allow to configure custom intrusion detection and object detection scenarios as well as allow to import settings to allow maximum flexibility.
- F. The analytics license shall allow to configure any one of these scenarios per camera.
- G. The analytics shall allow at least two different detection variants:
 - a. Trigger an alarm if a motion pattern moves from zone A (source) through zone B into zone C (sink).
 - b. Trigger an alarm if a motion pattern moves anywhere inside a specified zone.
- H. The analytics shall support an unlimited number of detection areas.
- I. The analytics feature rain-filters to filter out disturbances.

- J. The analytics shall feature live configuration to immediately see the effects of parameter changes in the configuration interface without prior saving new configurations.
- K. The configuration of the analytics shall be possible on recorded video streams.
- L. The analytics shall offer the possibility to configure object movement paths.
- M. The analytics shall not employ tripwires or crosslines.
- N. Areas and the scenes perspective (near & far object size) shall be configured on-screen using a point-and-click interface.
- O. The analytics shall feature filters for movement speed, distance, and direction to detect events.
- P. The analytics shall feature options to separately show or hide areas, area names, and detection overlays.
- Q. The analytics shall be fully server-based, with no calculation on cameras necessary.
- R. The analytics shall operate with color, thermal, and infrared cameras.

2.09 CAMERA INTEGRITY MONITOR

- A. Description:
 - 1. Automatically checks camera feeds to detect if cameras have been tampered with.
 - 2. Can be used for near-real-time alerting of tampering events or as a maintenance tool.
 - 3. Reports can be run on detected tampering events.
- B. Details:
 - 1. It shall be completely unified with the Video Management System.
 - 2. It shall be possible to set the detection sensitivity per camera stream between low, medium, and high.
 - 3. It shall be possible to choose on which servers the analytics shall run.
 - 4. The camera stream used for analytics shall be configurable.
 - 5. It shall be possible to define how many cameras are being analyzed at the same time.
 - 6. To utilize minimum hardware resources, it shall be definable how often camera streams are analyzed.
 - 7. There shall be an overview over which cameras are configured to be analyzed.

2.10 PRIVACY PROTECTOR

A. Description:

1. Automatically obscures all movement in surveillance videos in real-time.
2. Live privacy masking of moving objects (such as people and vehicles).
3. Completely unified with the video management system.
4. Native configuration in the configuration interface of the video management system.

B. Details:

1. Privacy masking can be removed either per camera or for all cameras currently viewed. Masking for all cameras viewed can be removed and added either manually with a button or automatically with an action.
2. Indoor / outdoor modes using flexible background modeling:
 - a. Indoor: Learning model with up to 10 different illumination states – this allows to adapt to fast lighting changes such as lights switching on and off.
 - b. Outdoor: Foreground detection based on edge detection rather than color – this allows to adapt to heavily changing lighting conditions such as clouds temporarily blocking sunlight.
3. Detects movements using an absolute difference image, calculated by subtracting the current frame from a calculated background model.
4. Masks movements using blocks, thus obscuring the outline of an object or person.
5. Three different scrambling methods: Pixelation, Colorize, and Transparency.
6. Masking grids can be configured in a point-and-click interface.
7. Past preview mode to see configuration changes in the configuration interface without necessity to save the configuration.
8. Zones can be freely definable polygons with a point-and-click interface.
9. Option to set analysis resolution to optimize performance.
10. No calculation on the camera necessary, completely server based.
11. Option to define zones, which should always or never be pixelated.
12. Option to choose input stream and output stream parameters, including resolutions, frame rate, and encoding.
13. Utilizes server-side hardware acceleration to maximize the amount of cameras

analyzed per server.

2.11 PEOPLE COUNTER

- A. The analytics shall feature dedicated configuration possibilities for the following scenarios:
 - 1. People counting
 - 2. Crowd estimation
- B. Description:
 - 1. Automatically counts people in a camera's field of view.
 - 2. Provides live dashboard widgets dedicated for people counting and crowd estimation.
 - 3. Completely unified in the video management system.
 - 4. Native configuration in the configuration interface of the video management system.
- C. Details:
 - 1. Based on deep-learning models trained on crowd size estimation to exclude non-human objects.
 - 2. Dedicated dashboard widgets for crowd estimation with the following features:
 - a. Charts: Displays the number of people inside the selected regions during a specific time on a bar or line chart.
 - b. Throughput: Show number of persons in given time frame.
 - c. Occupancy: Displays the number of people currently in the selected regions.
 - 3. Counts adults and children.
 - 4. Counts crowds of 5 up to more than 500 people in a single frame
 - 5. Counts persons in wheelchairs.
 - 6. Triggers events in regular intervals containing the estimated size of the crowd for the configured area. One event per area.
 - 7. Triggers events if more than a defined amount of people is counted in a defined area.
 - 8. Supports top-down camera views.
 - 9. Supports bi-directional counting.

10. Supports tilted camera views.
11. Option to show/hide overlays with detected persons and counting line with dedicated people, crowds, counting lines, and areas.
12. No GPU required to run.
13. The occupancy widget support resetting the count at a defined time option to define zones, which should always or never be pixelated.
14. Supports organizing cameras into areas and show these areas in widgets.
15. Utilizes server-side hardware acceleration to maximize the amount of cameras analyzed per server.
16. Counts can be integrated to external systems using CSV exports and a .NET SDK.

2.12 GENERAL CLIENT SOFTWARE REQUIREMENTS

- A. The Client Software Applications (CSA) shall provide the user interface for USP configuration and monitoring over any network and be accessible locally or from a remote connection.
- B. The CSA shall consist of the Configuration UI for system configuration and the Monitoring UI for monitoring. The CSA shall be Windows-based and provide an easy-to-use graphical user interface (UI).
- C. The CSA for monitoring shall support running in 64-bit mode.
- D. The Server Administrator shall be used to configure the server database(s). It shall be web-based and accessible locally on the SSM or across the network.
- E. The CSA shall seamlessly merge access control, license plate recognition (ALPR), and video functionalities within the same user application.
- F. The USP shall use the latest user interface (UI) development and programming technologies such as Microsoft WPF (Windows Presentation Foundation), the XAML markup language, and the .NET software framework.
- G. All applications shall provide an authentication mechanism, which verifies the validity of the user. As such, the administrator (who has all rights and privileges) can define specific access rights and privileges for each user in the system.
- H. Logging on to a CSA shall be done either through locally stored USP user accounts and passwords or using the operator's Windows credentials when Active Directory integration is enabled.
- I. When integrated with Microsoft's Active Directory, the CSA and USP shall authenticate users using their Windows credentials. As a result, the USP will benefit from Active Directory password authentication and strong security features.
- J. When integrated with an external identity provider such as Windows Active Directory,

ADFS (Active Directory Federation Services) or an Open ID Connect/SAML2 identity provider (ex.: Azure AD), the CSA and USP shall authenticate using a Single-Sign On experience to the users. As a result, the USP will benefit from reusing the same credential throughout enterprise applications.

K. To enhance usability and operator efficiency, the Configuration UI and Monitoring UI shall support many of the latest UI such as:

1. A customizable Home Page that includes favorite and recently used tasks.
2. Task-oriented approach for administrator/operator activities where each type of activity (surveillance, visitor management, individual reports, and more) is an operator task.
3. Consolidated and consistent workflows for video, ALPR, and access control.
4. Single click functionality for reporting and tracking. The Monitoring UI shall support both single-click reporting for access control, ALPR, and video, as well as single-click tracking of areas, cameras, doors, zones, cardholders, elevators, ALPR entities, and more. Single-click reporting or tracking shall create a new task with the selected entities to report on or track.

L. Configuration UI and Monitoring UI Home Page and Tasks

1. The Configuration UI and Monitoring UI shall be task oriented.
2. A task shall be user interface design patterns whose goal is to simplify the user interface by grouping related features from different systems, such as video and access, in the same display window. Features shall be grouped together in a task based on their shared ability to help the user perform a specific task.
3. Tasks shall be accessible via the Home Page of either the Configuration or the Surveillance CSA.
4. Newly created tasks shall be accessible via the Configuration UI or the Monitoring UI taskbar.
5. Similar tasks shall be grouped into the following categories:
 - a. Operation: Access control management, LRP management, and more.
 - b. Investigation: Video bookmark/motion/archive reports, access control activity reports, visitor activity reports, alarm reports, ALPR activity reports, and more.
 - c. Maintenance: Access control and video configuration reports, troubleshooters, audit trails, health-related reports, and more.
6. An operator shall be able to launch a specific task only if they have the appropriate privileges.
7. The Home Page content shall be customizable through the use of privileges to hide

tasks that an operator should not have access to and through a list of favorite and recently used tasks. In addition, editing a USP XML file to add new tasks on the fly shall also be possible.

2.13 CONFIGURATION USER INTERFACE (UI)

A. General:

1. The Configuration UI application shall allow the administrator or users with appropriate privileges to change the system configuration. The Configuration UI shall provide decentralized configuration and administration of the USP system from anywhere on the IP network.
2. The configuration of all embedded ACS, VMS, and ALPR systems shall be accessible via the Configuration UI.
3. The Configuration UI shall have a home page with single-click access to various tasks.
4. The Configuration UI shall include a variety of tools such as troubleshooting utilities, import tools, and a unit discover tool, amongst many more.
5. The Configuration UI shall include a static reporting interface to:
 - a. View historical events based on entity activity. The user shall be able to perform such actions as printing a report and troubleshooting a specific access event from the reporting view.
 - b. View audit trails that show a history of user/administrator changes to an entity.
6. Common entities such as users, schedules, alarms and many more, can be reused by all embedded systems (ACS, VMS, and ALPR).

B. Video management system:

1. The Configuration UI shall allow the administrator or users with appropriate privileges to change video configuration.
2. The Configuration UI shall provide the ability to change video quality, bandwidth, and frame rate parameters on a per camera (stream) basis for both live and recorded video.
3. The Configuration UI shall provide the ability to change video quality by a selection of predefined video quality template.
4. The Configuration UI shall provide the ability to configure brightness, contrast, and hue settings for each camera on the same DVS.
5. The Configuration UI shall provide the capability to enable audio recording on DVS units that support audio.

6. The Configuration UI shall provide the ability to change the audio parameters, serial port and I/O configuration of individual DVS units.
7. The Configuration UI shall provide the capability to rename all DVS units based on system topology and to add descriptive information to each DVS.
8. The Configuration UI shall provide the ability to set recording schedules and modes for each individual camera. The recording mode can be:
 - a. Continuous
 - b. On motion and Manual
 - c. Manual only
 - d. Disabled
9. The Configuration UI shall support the creation of schedules to which any of the following functional aspects can be attached:
 - a. Video quality (for each video stream per camera)
 - b. Recording (for each camera)
 - c. Motion detection (for each detection zone per camera)
 - d. Brightness, Contrast, and Hue (for each camera)
 - e. Camera sequence execution
10. The Configuration UI shall support the creation of unlimited recording schedules and the assigning of any camera to any schedule.
11. The Configuration UI shall detect and warn user of any conflict within assigned schedules.
12. The Configuration UI shall provide the capability to set a PTZ protocol to a specific DVS serial port and shall allow mixing domes of various manufacturers within a system.
13. User shall have the ability to configure a return to home function after a predefined time of inactivity for PTZ cameras. This period of inactivity time shall be configurable from 1 to 7200 seconds.

2.14 VMS CLIENT USER INTERFACE (UI)

- A. The Monitoring UI shall fulfill the role of a Unified Security Interface that is able to monitor video, ALPR, and access control events and alarms, as well as view live and recorded video.
- B. The Monitoring UI shall provide a graphical user interface to control and monitor the USP over any IP network. It shall allow administrators and operators with appropriate privileges

to monitor their unified security platform, run reports, and manage alarms.

C. To enhance usability and operator efficiency, the Monitoring UI shall support the following UI concepts:

1. Dynamically adaptive interface that adjusts in real-time to what the operator is doing.
2. A dynamic controls section loaded with entity-specific widgets (e.g., door and camera widgets).
3. Use of transparent overlays that can display multiple types of data in a seamless fashion.
4. Display tile menus and quick commands.
5. Consolidated and consistent workflows.
6. Tile menus and quick commands easily accessible within every display tile of the user workspace.
7. Single click functionality for reporting and tracking. The Monitoring UI shall support both single-click reporting for access control, ALPR, and video, as well as single-click tracking of areas, cameras, doors, zones, cardholders, elevators, ALPR entities, and more. Single-click reporting or tracking shall create a new task with the selected entities to report on or to track.

D. Monitoring UI Home Page and Tasks:

1. Similar tasks shall be grouped into the following categories:
 - a. Operation: Access control/LRP/video surveillance, visitor management, mustering, access control and video alarm monitoring, and more.
 - b. Investigation: Video bookmark/motion/archive reports, access control activity reports, visitor activity reports, alarm reports, ALPR activity reports, and more.
 - c. Maintenance: Access control and video configuration reports, troubleshooters, audit trails, and more.

E. Dynamically Adaptive UI, Controls section, and Widgets:

1. The Monitoring UI shall dynamically adapt to what the operator is doing. This shall be accomplished through the concept of widgets that are grouped in the Monitoring UI Controls section.
2. Widgets shall be mini-applications or mini-groupings in the Monitoring UI Controls section that let the operator perform common tasks and provide them with fast access to information and actions.
3. With a single click on an entity (for example door or camera) the specific widgets

associated to that entity appear and other non-relevant widgets disappear dynamically (instantly). Widgets shall bring the operator information such as door status and camera stream information, as well as user actions, such as door unlock, PTZ controls, and more.

4. Specific widgets include those for a door, camera, alarm, zone, display tile, video stream (statistics), PTZ camera, and more.

F. Operator Workflows:

1. A workflow shall be a sequence of operations an operator or administrator shall execute to complete an activity. The “flow” relates to a clearly defined timeline or sequence for executing the activity.
2. The Monitoring UI shall be equipped with consistent workflows for the ALPR, video, and access control systems that it unifies.
3. Generating or printing a report, setting up or acknowledging an alarm, or creating an incident report shall follow the same process (workflow) whether the operator is working with video, ALPR, or access control, or with both video and access control.

G. Each task within the Monitoring UI shall consist of one or more of the following items:

1. Event list.
2. Logical tree: Doors, cameras, zones, ALPR units, and elevators shall be grouped under Areas in a hierarchical fashion.
3. Entities list of all entities being tracked.
4. Display tiles with various patterns (1 x 1, 2 x 2, and more).
5. Display tile menu with various commands related to cameras, doors, PTZ, and tile controls.
6. Controls section with widgets.

H. The Monitoring UI shall support multiple event lists and display tile patterns, including:

1. Event/alarm list layout only
2. Display tile layout only
3. Display tile and alarm/event list combination
4. ALPR map and alarm/event list combination

I. User workspace customization

1. The user shall have full control over the user workspace through a variety of user-selectable customization options. Administrators shall also be able to limit what

- users and operators can modify in their workspace through privileges.
2. Once customized, the user shall be able to save his or her workspace.
 3. The user workspace shall be accessible by a specific user from any client application on the network.
 4. Display tile patterns shall be customizable.
 5. Event or alarm lists shall span anywhere from a portion of the screen up to the entire screen and shall be resizable by the user. The length of event or alarm lists shall be user-defined. Scroll bars shall enable the user to navigate through lengthy lists of events and alarms.
 6. The Monitoring UI shall support multiple display tile patterns (for example one display tile (1x1 matrix), 16 tiles (8x8 matrix), and multiple additional variations).
 7. The Monitoring UI shall support as many monitors as the PC video adapters and Windows Operating System are capable of accepting.
 8. Additional customization options include show/hide window panes, show/hide menus/toolbars, show/hide overlaid information on video, resize different window panes, and choice of tile display pattern on a per task basis.
- J. The Monitoring UI shall provide an interface to support the following tasks and activities common to access control, ALPR, and video:
1. Monitoring the events from a live security system (ACS and/or VMS and/or ALPR).
 2. Generating reports, including custom reports.
 3. Monitoring and acknowledging alarms.
 4. Creating and editing incidents and generating incident reports.
 5. Displaying dynamic graphical maps and floor plans as well as executing actions from dynamic graphical maps and floor plans.
 6. Management and execution of hot actions and macros.
- K. The Monitoring UI shall be able to monitor the activity of the following entities in real-time: areas, ALPR entities, doors, elevators, cameras, cardholders, cardholder groups, zones (input points), and more.
- L. The Monitoring UI shall include advanced video capabilities, including:
1. Advanced live video viewing functionality.
 2. Advanced archive playing and video playback functionality.
 3. Monitoring and management of video system events and alarms.

4. Intercom or duplex audio.
 5. Generation of video reports.
 6. Control of PTZ cameras.
 7. Creating and monitoring archive transfer requests.
 8. Display metadata overlaid on live or playback video.
- M. The Monitoring UI shall leverage the Graphical Processing Unit (GPU) for video decoding.
1. The following GPU technologies shall be supported:
 - a. NVidia CUDA
 - b. Intel Quick Sync
 2. The Monitoring UI shall have the ability to decode video through the optimal simultaneous use of the GPU and Computer Processing Units (CPU).
- N. The live video viewing capabilities of the Monitoring UI shall include:
1. The ability to display all cameras attached to the USP and all cameras attached to federated systems.
 2. Support for live video monitoring on each and every display tile within a task in the user's workspace.
 3. The USP shall support uninterrupted video streaming. The CSA shall keep existing video connections active in the event that an SSM (except Archiver) becomes unavailable.
 4. The ability to drag and drop a camera into a display tile for live viewing.
 5. The ability to drag and drop a camera into a display tile for live viewing on an analog monitor connected to an IP hardware decoder (converting an IP encoded stream into an analog video signal).
 6. The ability to drag and drop a camera from a map into a display tile for live viewing.
 7. Support for digital zoom on live camera video streams.
 8. The ability for audio communication with video units with audio input and output.
 9. The ability to control pan-tilt-zoom, iris, focus, and presets.
 10. The ability to bookmark important events for later retrieval on any archiving camera and to uniquely name each bookmark in order to facilitate future searches.
 11. The ability to start/stop recording on any camera in the system that is configured

- to allow manual recording by clicking on a single button.
12. The ability to activate or de-activate viewing of all system events as they occur.
 13. The ability to switch to instant replay of the video for any archiving camera with the simple click of button.
 14. The ability to take snapshots of live video and be able to save or print the snapshots.
 15. The ability to view the same camera multiple times in different tiles.
- O. The video playback (archive playing) capabilities of the Monitoring UI shall include:
1. Support for audio and video playback for any time span.
 2. Support for video playback on each and every display tile.
 3. The ability to instantly replay the video for any archiving camera with the simple click of a button.
 4. The ability to select between instant synch of all video streams in playback mode, allowing operators to view events from multiple angles or across several camera fields, or non-synchronous playback.
 5. The ability to simultaneously view the same camera in multiple tiles at different time intervals.
 6. The ability to control playback with:
 - a. Pause
 - b. Lock Speed
 - c. Forward and Reverse Playback at: 1x, 2x, 4x, 6x, 8x, 10x, 20x, 40x, 100x
 - d. Forward and Reverse Playback frame by frame
 - e. Slow Forward and Reverse Playback at: 1/8x, 1/4x, 1/3x, 1/2x
 - f. Loop playback between two time markers
 7. The ability to display a single timeline or one timeline for each selected video stream, which would allow the operator to navigate through the video sequence by simply clicking on any point in the timeline.
 8. The ability to display the level of motion at any point on a timeline.
 9. The ability to clearly display bookmarked events on the timeline(s).
 10. The ability to query archived video using various search criteria, including, but not limited to, time, date, camera, and area.

11. The tool necessary for searching video and associated audio based on user-defined events or motion parameters.
12. The ability to define an area of the video field in which to search for motion as well as define the amount of motion that will trigger search results. The Monitoring UI shall then retrieve all archived video streams that contain motion that meets the search parameters. There shall be a graphical timeline on which the time of each search hit shall be indicated.
13. The ability to browse through a list of all bookmarks created on the system and select any bookmarked event for viewing.
14. The ability to add bookmarks to previously archived video for easier searching and retrieval.
15. Support for digital zoom on playback video streams.
16. Still image export to PNG, JPEG, GIF, and BMP format with Date and Time stamp, and Camera Name on the image (snapshot).
17. Tools for exporting video and a self-contained video player on various media such as USB keys or CD/DVD-ROM. This video player shall be easy to use without training and shall still support reviewing video metadata, such as bookmark, or navigating the video with functions like panoramic camera view dewarping.
18. Tools for exporting video sequences in standard video formats, such as ASF or MP4.
19. The ability to encrypt exported video files.
20. The ability for an operator to load previously exported video files from their computer or network.
21. The ability for queries to be saved upon closing the CSA and reappear when the application is reopened.
22. The ability to dynamically block, on demand, video stream dynamically to lower-level users to prevent access, for a specific time, to live and recorded video.
23. A tool building and exporting a set of videos into a single container. This tool shall allow the operator to build sequences of video to create a storyboard and allow the export of synchronous cameras.
24. The ability to store the video export and still image export at a pre-defined storage location.
25. An interface with the ability to list, search, and manipulate previously generated video exports.
26. The ability to export sequences of video in open standards including ASF and MP4.

- P. The Monitoring UI shall provide an interface to support the following ALPR tasks and capabilities:
1. Monitoring and management of ALPR events and alarms.
 2. Viewing of license plate picture(s) and context images.
 3. Viewing of license plate data (e.g., license plate reads)
 4. Verification of ALPR data against live and recorded video.
- Q. Entity Monitoring:
1. The USP shall permit the user to select multiple entities to monitor from the Monitoring UI by adding the entities one by one to the tracking list.
 2. The Monitoring UI shall provide the option to filter which events shall be displayed in the display tile layout and/or event list layout.
 3. It shall be possible to lock a Monitoring UI display tile so that it only tracks the activity of a specific entity (e.g., specific door or camera).
 4. The user shall be able to drag and drop an event from an event list (or an alarm from an alarm list) onto a display tile to view a license plate read, cardholder picture ID, badge ID, or live/archived video, among other options.
 5. Event, alarm, monitoring/tracking, and report lists shall contain cardholder pictures where applicable.
 6. The user shall be permitted to start or pause the viewing of events within each display tile.
- R. Display Tile Packing and Unpacking:
1. The Monitoring UI shall support single-click unpacking and packing for ALPR hits, ALPR reads, areas, doors, zones, camera sequences, and alarms.
 2. The packing and unpacking of entities shall allow operators to quickly obtain additional information and camera views of a specific entity.
 3. The unpacking of an entity shall display associated entities. For example, unpacking a door with multiple associated cameras shall display all cameras associated with that door. Unpacking shall reconfigure the display tiles to be able to display all associated entities. For example, unpacking a door (or a zone or alarm) that is currently in a 1 x 1 tile configuration and that has 3 cameras tied to it will create a 1 x 3 display tile arrangement for viewing all associated entities.
 4. Packing will return the display to the original tile pattern.
- S. Visual Tracking:
1. The Monitoring UI shall support the ability to manually track a moving target with

the single click of a button.

2. The ability to switch from one camera view to an adjacent camera shall be done within a single display tile.
3. Switching between camera streams shall be accomplished by simply clicking on a semi-transparent shape or overlay.
4. Visual tracking shall be available with both live and recorded video.

2.15 SERVER ADMINISTRATOR USER INTERFACE REQUIREMENTS

- A. The Server Administrator shall be used to configure the SSM and the Directory Role (main configuration) and its database(s), to apply the license, and more.
- B. The Server Administrator shall be a web-based application. Through the Server Administrator, it shall be possible to access the SSM across the network or locally on the server.
- C. Access to the Server Administrator shall be protected via login name, password, and encrypted communications.
- D. The Server Administrator shall allow the administrator (user) to perform the following functions:
 1. Manage the system license.
 2. Configure the database(s) and database server for the Directory Role,
 3. Activate/Deactivate the Directory Role.
 4. Manually back up the Directory Role database(s) and/or restore the server database(s), as well as configure scheduled backups of the databases.
 5. Define the client-to-server communications security settings.
 6. Configure the network communications hardware, including connection addresses and ports.
 7. Configure system SMTP settings (mail server and port).
 8. Configure event and alarm history storage options.

2.16 UNIFIED WEB INTERFACE (UWI) GENERAL REQUIREMENTS

- A. The USP shall support a unified web interface (UWI) for access control and video.
- B. The UWI shall be a truly thin client with no download required other than an internet web browser or standard web browser plugins.
- C. The UWI shall be platform independent and run within Microsoft Edge, Internet Explorer, Firefox, Safari, and Google Chrome.

- D. Web pages for the web interface shall be managed and pushed by the Web Server Role. Microsoft IIS or any other web hosting service shall not be required given that all the web pages shall be hosted by the Web Server Role.
- E. The UWI shall support display on tablet format.
- F. The UWI shall support native H.264 video in the web interface.
- G. Web pages for the web interface shall be managed and pushed by the Web Interface Server. Microsoft IIS or any other web hosting service shall not be required given that all the web pages shall be hosted by the Mobile Server.
- H. The Web Interface Server shall provide the ability to define a unique URL to access the web interface, to ensure the security of the application.
- I. The UWI shall provide the ability to load a camera layout.
- J. The UWI shall provide the ability to configure, save, and reload private camera layouts.
- K. The UWI shall provide the ability to control PTZ cameras.
- L. Functionalities:
 - 1. Log in support shall be available using:
 - a. Username and password
 - b. Active Directory.
 - c. Azure Active Directory, ADFS, OpenID Connect or SAML2 identity provider.
 - d. Ability for user to change their password.
 - 2. Encrypted communications for all transactions.
 - 3. Print reports and export to CSV file.
 - 4. Customer logo customization shall be available for multi-tenant and hosted services applications.
 - 5. Video:
 - a. Live and playback video at 320 x 240, 640 x 480 or 1280 x 1024 @ 15 fps
 - b. Video export
 - c. 1, 4, 6 or 9 tiles
 - d. Basic PTZ Controls (Pan/Tilt, Zoom, go to presets, start pattern)
 - e. Start / Stop recording

- f. Sample web page for customers to see how to view video for their own development
- g. Add bookmarks
- 6. Alarms:
 - a. Alarm report
- 7. Threat Level.

2.17 SMARTPHONE AND TABLET APP GENERAL REQUIREMENTS

- A. The USP shall support mobile apps for various off-the-shelf devices. The mobile apps shall communicate with the Mobile Server of the USP over any Wi-Fi or cellular network connection.
- B. Mobile apps shall communicate with the USP via a Mobile Server Role (MSR). All communication between the mobile apps and MSR shall be based on standard TCP/IP protocol and shall use the TLS encryption with digital certificates to secure the communication channel.
- C. Supported device manufacturers shall include (refer to Mobile App specifications for latest compatibility list):
 - 1. Apple devices running iOS 13.0 or later
 - 2. Android devices 10.0 or later
- D. It shall be possible to download the mobile apps from the Central application store (Apple iTunes App Store, Google Play).
- E. It shall be possible to push configuration to the mobile devices through a Mobile Device Management solution such as VMWare Workspace One or Microsoft Intune.
- F. Functionalities:
 - 1. Core
 - a. Ability to logon/logoff to the USP using an authorized user profile of the system.
 - b. Ability to support passive authentication from a single sign-on provider (OpenID Connect or SAML2 identity provider).
 - c. Ability to use biometric features (thumbprint, face ID, etc.) to perform connection to the system.
 - d. Ability to change the picture or the password of the user of the mobile app.
 - e. Ability to view the current Threat Level of the system.

- f. Ability to change the current Threat Level of the system.
- g. Ability to execute hot actions configured in the user profile.
- h. Ability to view entities from the USP:
 - (1) Cameras
 - (2) Doors
 - (3) ALPR cameras
 - (4) Web Tile Plugins
 - (5) Layouts
 - (6) Camera Sequences
 - (7) Macros
- i. Ability to navigate the system hierarchical view of the entities and search entities in the system.

2. Video

- a. Ability to view live and recorded video from the cameras of the USP. A maximum of four cameras shall be displayed.
- b. Ability to view video in native format (H.264).
- c. Ability to display live and recorded video side-by-side for a specific camera.
- d. Ability to perform digital zoom on cameras.
- e. Ability to perform actions on cameras such as add a bookmark, control a PTZ, control the iris/focus function, save a snapshot, start/stop recording.
- f. Ability to view camera layouts.
- g. Ability to view camera sequences.
- h. Ability to run a camera events report.
- i. Ability to change the video quality on the cameras displayed on the mobile app.
- j. Ability to use the camera of the smartphone and stream a live video feed to a video recorder in the system.

3. Access Control

- a. Ability to view the door state and door lock state.
- b. Ability to perform actions on a door such as unlock the door, set the door in maintenance mode, override the door unlocking schedule.
- c. Ability to monitor live cardholder activities per door, such as cardholder name, pictures, access denied and reason for access denied.

4. Automatic License Plate Recognition

- a. Ability to view live events raised by an ALPR camera.
- b. Ability to view the read image, context image, and all metadata captured by the ALPR camera.
- c. Ability to run an ALPR event report.
- d. Ability to add a license plate to a hotlist on the system.

5. Alarm Management

- a. Ability to receive push notifications to notify mobile operators that an alarm was received.
- b. Ability to view all active alarms assigned to the mobile operator.
- c. Ability to perform action on an alarm such as acknowledge, investigate, or alternate-acknowledge an active alarm.
- d. Ability to view entities attached to the alarm.

G. It shall be possible to send a message from the client user interface to a mobile operator.

H. It shall be possible to send a live or playback video sequence from the client UI to a mobile operator.

2.18 HEALTH MONITOR

- A. The USP shall monitor the health of the system, log health-related events, and calculate statistics.
- B. USP services, roles, agents, units, and client apps will trigger health events.
- C. The USP shall populate the Windows Event Log with health events related to USP roles, services, and client apps.
- D. A dedicated role, the Health Monitoring Role, shall perform the following actions:
 - 1. Monitor the health of the entire system and log events.
 - 2. Calculate statistics within a specified time frame (hours, days, months).

3. Calculates availability for clients, servers and video/access/ALPR units.
- E. A Health Monitoring task and Health History reporting task shall be available for live and historical reporting.
- F. A Health Monitoring dashboard task shall be available in the client application user interface to provide a live display, such as pie charts and event lists, for quick visual assessment on the general health of the system.
- G. A web-based, centralized health dashboard shall be available to remotely view unit and role health events of the USP.
- H. Detailed system care statistics will be available through a web-based dashboard providing health metrics of USP entities and roles, including Uptime and mean-time-between-failures.
- I. All health events raised in the system can be used for automating the USP event/action management.
- J. Health events shall be accessible via the SDK (can be used to create SNMP traps).

2.19 SESSION INITIATION PROTOCOL (SIP) COMMUNICATION MANAGEMENT (CM)

- A. An operator of the USP shall be able to, within the USP Monitoring UI, initiate calls to and answer calls from other operator and edge voice devices such as intercoms, emergency call stations, information desks, softphones, or phone devices.
- B. The USP shall support CM between the USP client User Interface and SIP endpoint devices.
- C. SIP endpoints shall be able to register to the USP using a standard SIP protocol.
- D. The USP shall support CM between two SIP endpoint devices.
- E. The USP shall allow the configuration of SIP trunk connections to multiple SIP Servers supporting SIP Trunks.
- F. The CM shall support the management of calls to and from other SIP Servers connected through SIP Trunks.
- G. The USP shall support the configuration of paging zones for pre-recorded and live message announcements.
- H. The CM is a service of the USP and shall not require the addition of any third-party software.
- I. The CM shall support the following video codecs:
 1. H.264
 2. H.263

3. H.263+ (1998)

J. The CM shall support the following audio codecs:

1. PCMA (G.711 aLaw)
2. PCMU (G.711 uLaw)
3. G.722
4. G.729
5. iLBC
6. GSM
7. telephone event
8. Speex (Narrowband)
9. Speex (Wideband)
10. Speex (Ultrawideband)
11. L.16
12. L.16-44-1
13. G.728
14. G.726-16
15. G.726-24
16. G.726-32
17. G.723
18. G.726-40

K. The CM shall allow bidirectional audio and video recording of call sessions. The USP shall offer the following recording capabilities:

1. Automatic cleanup of call session files after a programmable number of days.
2. Deactivation of call recording between operators.
3. Deactivation of call recording with specific operators.
4. Deactivation of call recording with specific voice devices.
5. Selection of the storage path for call session recordings.

- L. The CM shall provide the capability to reach a physical location identified by its own extension number regardless of the user connected to the USP.
- M. The CM shall provide the flexibility for the administrator to define the network ports used to communicate between the USP servers and the following:
 - 1. USP Operator Client User Interfaces
 - 2. SIP devices
 - 3. SIP servers
- N. The USP shall unify, within a simple user interface, the workflow between the associated security entities of a call session, including the call box, cameras, doors, intrusion zones and outputs.
- O. The USP shall support video and audio calls:
 - 1. Between USP Client User Interfaces
 - 2. To and from USP Client User Interfaces and SIP devices
 - 3. Between SIP devices
- P. The USP shall provide an advanced and friendly call management user interface that allows operators to:
 - 1. Connect standard USB headsets and webcams to USP Client User Interface workstations so that USP users can make voice and video calls through the USP Client User Interface.
 - 2. Display the video associated with the call and switch between multiple video sources.
 - 3. Receive incoming call notifications directly through a notification tray.
 - 4. Initiate, answer, forward, place on hold, or cancel calls from a dedicated call dialog box.
 - 5. Control cameras, doors, zones, and device outputs during a call.
 - 6. Create a customizable list of contacts, so that users can quickly call their contacts. Contact lists shall include other USP users, as well as SIP devices.
 - 7. Dial a phone number to make a call.
 - 8. Dial a DTMF sequence during a call.
 - 9. Monitor the availability status of a user and set its own availability status.
 - 10. Access a history log of calls that the operator both initiated and received. This log shall show the time of the call, duration, direction and the reason for its ending. It

shall be possible to redial one of the entries in the log.

- Q. The USP shall allow an operator to manage up to 10 calls simultaneously. The call queue shall show the status of each call: incoming, in call, or on hold. It shall be possible to hold and resume a call directly from the call queue.
- R. The USP shall offer a call window. It shall be possible within the call windows to:
1. Switch between cameras associated with the call participant.
 2. Open and lock doors associated with the call participant.
 3. Arm and Disarm zones associated with the call participant.
 4. Trigger outputs associated with the call participant.
 5. Put on hold, resume, forward, and end a call.
 6. Mute the microphone.
 7. Hide the webcam video feed.
- S. The USP shall have a built-in address book. The address book shall be available in the call dialog box, in which users can view and manage their list of contacts. From the address book, users shall be able to do the following:
1. Call a contact by simply double-clicking the contact name.
 2. See the availability status of their contacts (users and SIP Devices).
 3. Quickly display a contact's information, such as photo, name, and number.
 4. Filter their contacts by type (SIP Device or User).
 5. Create a list of favorites by adding and removing contacts.
 6. Search for and call numbers that appear in the contact list.
- T. The USP shall provide a graphical dial pad to allow the operator to make calls and dial DTMF tones during a call.
- U. The USP shall provide the ability to send public announcements via a microphone or uploaded pre-recorded messages. The users shall be able to do the following:
1. Create paging zones.
 2. Associate any SIP callable entity with a paging zone.
 3. Upload pre-recorded messages.
 4. Trigger a live or pre-recorded message.

- V. The USP shall provide call reporting capabilities to allow for the investigation of the activities during specific call sessions. The report shall provide the capability to replay audio recordings and watch call sessions that have associated video. The Call report shall provide filters to query the call records by:
 - 1. Date and time
 - 2. Call session duration
 - 3. Involved users and call stations
 - 4. Call events and actions
 - 5. Actions taken by a user on doors, intrusion zones, and outputs during the call session

- W. The USP shall give the capability to export a call session, including bidirectional audio, associated video, and log journal of the call session.

- X. It shall be possible to place the voice devices as icons on a map that shall display the call status of the voice device with a color code. A right click on the voice device map icon shall allow the user to:
 - 1. Answer or reject an incoming call.
 - 2. Initiate a call to the device.
 - 3. Put on hold and resume a call with the device.

- Y. It shall be possible for an operator to select and broadcast his or her availability status, with the possible statuses being Available, Away and Busy. This status will appear with a color code in the call dialog box of other operators.

- Z. It shall be possible to do a failover and bidirectional audio and video recording for each SIP device.

- AA. It shall be possible to do SIP public address.

- BB. The CM shall provide the ability to broadcast public addressing messages to a collection of SIP devices included in a paging zone. The PA (Public address) feature shall support the following capability:
 - 1. Define paging zones and assign SIP entities for each of them
 - 2. Broadcast live and pre-recorded messages

2.20 USP GENERAL REQUIREMENTS

- A. The Unified Security Platform (USP) shall be an enterprise class IP-enabled security and safety software solution.
- B. The USP shall support the seamless unification of IP access control system (ACS), IP video

management system (VMS), and IP automatic license plate recognition system (ALPR) under a single platform. The USP user interface (UI) applications shall present a unified security interface for the management, configuration, monitoring, and reporting of embedded ACS, VMS, and ALPR systems and associated edge devices.

- C. Functionalities available with the USP shall include:
 - 1. Configuration of embedded systems, such as ACS, ALPR, and VMS systems.
 - 2. Live event monitoring.
 - 3. Live video monitoring and playback of archived video.
 - 4. Alarm management.
 - 5. Reporting, including creating custom report templates and incident reports.
 - 6. SIP Intercom device integration for bi-directional communication.
 - 7. Integration with third party systems and databases via plug-ins (access control, video analytics, point of sale, and more).
 - 8. Dynamic graphical map viewing.
 - 9. Asset management system integration.
- D. The USP shall be deployed in one or more of the following types of installations:
 - 1. Unified access, ALPR, video platform, and any combination thereof.
 - 2. Standalone access control, ALPR, or video platform.
 - 3. Unified access and video platform that federates multiple remote ACS, VMS, ALPR.
 - 4. Standalone video platform that federates multiple independent remote VMS.
 - 5. Standalone access control that federates multiple independent remote ACS.
 - 6. Standalone access control that federates multiple independent remote ALPR.
- E. Licensing:
 - 1. A single central license shall be applied centrally on the configuration server.
 - 2. There shall be no requirement to apply a license at every server computer or client workstation.
 - 3. Based on selected options, one or more embedded systems shall be enabled or disabled.
- F. Hardware and Software Requirements:

1. The USP and embedded systems (video, license plate recognition, and access control) shall be designed to run on a standard PC-based platform loaded with a Windows operating system. The preferred operating system shall be coordinated with the Owner following the manufacturer supported operating systems.
2. The core client/server software shall be built in its entirety using the Microsoft .NET software framework and the C# (C-Sharp) programming language.
3. The USP database server(s) shall be built on Microsoft's SQL Server. The preferred SQL version shall be coordinated with the Owner and compatible with the USP.
4. The USP shall be compatible with virtual environments, including VMware and Microsoft Hyper-V.
5. The USP shall use the latest user interface (UI) development and programming technologies such as Microsoft WPF (Windows Presentation Foundation), the XAML markup language, and .NET software framework.

2.21 USP ARCHITECTURE

- A. The USP shall be based on a client/server model. The USP shall consist of a standard Server Software Module (SSM) and Client Software Applications (CSA).
- B. The USP shall be an IP enabled solution. All communication between the SSM and CSA shall be based on standard TCP/IP protocol and shall use TLS encryption with digital certificates to secure the communication channel.
- C. The SSM shall be a Windows service that can be configured to start when the operating system is booted and run in the background. The SSM shall automatically launch at computer startup, regardless of whether or not a user is logged on the machine.
- D. Users shall be able to deploy the SSM on a single server or across several servers for a distributed architecture. The USP shall not be restricted in the number of SSM deployed.
- E. The USP shall protect against potential database server failure and continue to run through standard off-the-shelf solutions.
- F. The USP shall support an unrestricted number of logs and historical transactions (events and alarms) with the maximum allowed being limited by the amount of hard disk space available.
- G. The USP shall support uninterrupted video streaming. The CSA shall keep existing video connections active in the event that an SSM (except Archiver) becomes unavailable.
- H. Roles-Based Architecture:
 1. The USP shall consist of a role-based architecture, with each SSM hosting one or more roles.
 2. Each role shall execute a specific set of tasks related to either core system,

automatic license plate recognition (ALPR), video (VMS), or access control (ACS) functionalities, among many others. Installation shall be streamlined through the ability of the USP to allow administrators to:

- a. Deploy one or several SSM across the network prior to activating roles.
 - b. Activate and deactivate roles as needed on each and every SSM.
 - c. Centralize role configuration and management.
 - d. Support remote configuration.
 - e. Move roles over from one SSM to another.
3. Each role, where needed, shall have its own database to store events and role-specific configuration information.
 4. Roles without databases, such as The Federation feature, Active Directory, and Global Cardholder Management, shall support near real-time standby without any third-party failover software being required.
 5. Directory Role:
 - a. The Directory Role shall manage the central database that contains all the system information and component configuration of the USP.
 - b. The Directory Role shall authenticate users and give access to the USP based on predefined user access rights or privileges, and security partition settings.
 - c. The Directory Role shall support the configuration/management of the following components common to the ACS, ALPR, and VMS sub-systems:
 - (1) Security Partitions, users and user groups
 - (2) Areas
 - (3) Zones, input/output (IO) linking rules, and custom output behavior
 - (4) Alarms, Schedules, and scheduled tasks
 - (5) Custom events
 - (6) Macros or custom scripts
 - d. The Directory Role shall support the configuration/management of the following components specific to VMS:
 - (1) Video servers and their peripherals (e.g., audio, IOs, and serial ports)

- (2) PTZ
 - (3) Camera sequences
 - (4) Recording and archiving schedules
- e. The Directory Role shall support the configuration/management of the following components specific to ACS:
 - (1) Door controllers, and input and output (IO) modules
 - (2) Doors, Elevators, and Access rules
 - (3) Cardholders and cardholder groups, credentials, and badge templates
- f. The Directory Role shall support the configuration/management of the following components specific to ALPR:
 - (1) ALPR units and cameras
 - (2) Hotlists, permit lists, and overtime rules
- 6. The Video Archiver Role shall be responsible for managing cameras and encoders under its control and archiving.
- 7. The Media Router Role shall be responsible for routing video and audio streams across local and wide area networks from the source (for example DVS) to the destination (for example CSA).
- 8. The Access Manager Role shall be responsible for synchronizing access control hardware units under its control, such as door controllers and I/O modules. This role shall also be responsible for validating and logging all access activities and events when the door controllers and I/O modules are online.
- 9. The Automatic License Plate Recognition (ALPR) Role shall be responsible for synchronizing fixed ALPR units (cameras) and mobile ALPR applications under its control. The ALPR Role shall also be responsible for logging all ALPR activities and events.
- 10. The Zone Manager Role shall be responsible for managing all software zones (collection of inputs) and logging associated zone events. Zones shall consist of inputs from both access control and video devices.
- 11. The Health Monitoring Role shall be responsible for monitoring and logging health events and warnings from the various client applications, roles, and services that are part of the USP. This role shall also be responsible for logging events within the Windows Event Log and for generating reports on health statistics and health history.

2.22 USP ACCESS CONTROL, VIDEO, AND ALPR UNIFICATION

- A. The Monitoring UI shall present a true Unified Security Interface for live monitoring and reporting of the ACS, VMS, and ALPR. Advanced live video viewing and playback of archived video shall be available through the Monitoring UI.
- B. The Configuration UI shall present a true Unified Security Interface for the configuration and management of the ACS, VMS, and ALPR.
- C. The user shall be able to associate one or more video cameras to the following entity types: areas, doors, elevators, zones, alarms, intrusion panels, ALPR cameras, and more.
- D. It shall be possible to view video associated to access control events when viewing a report.
- E. It shall be possible to view video associated to intrusion panel events when viewing a report.
- F. It shall be possible to view video associated to ALPR events when viewing a report.
- G. The USP shall support the following Alarm Management functionality:
 - 1. Create and modify user-defined alarms. An unrestricted number of user-defined alarms shall be supported.
 - 2. Assign a time schedule or a coverage period to an alarm. An alarm shall be triggered only if it is a valid alarm for the current time period.
 - 3. Set the priority level of an alarm and its reactivation threshold.
 - 4. Define whether to display live or recorded video, still frames or a mix once the alarm is triggered.
 - 5. Provide the ability to display live and recorded video within the same video tile using picture-in-picture (PiP) mode.
 - 6. Provide the ability to group alarms by source and by type.
 - 7. Define the time period after which the alarm is automatically acknowledged.
 - 8. Define the recipients of an alarm. Alarm notifications shall be routed to one or more recipients. Recipients shall be assigned a priority level that prioritizes the order of reception of an alarm.
 - 9. Define the alarm broadcast mode. Alarm notifications shall be sent using either a sequential or an all-at-once broadcast mode.
 - 10. Define whether to display the source of the alarm, one or more entities, or an HTML page.
 - 11. Specify whether an incident report is mandatory during acknowledgment.
- H. The workflows to create, modify, add instructions and procedures, and acknowledge an

alarm shall be consistent for access control, ALPR, and video alarms.

- I. Alarms shall be federated, allowing global alarm management across multiple independent USP, ACS, VMS, and ALPR systems.
- J. The USP shall also support alarm notification to an email address or any device using the SMTP protocol.
- K. The ability to create alarm-related instructions shall be supported through the display of one or more HTML pages following an alarm event. The HTML pages shall be user-defined and can be interlinked.
- L. Alarm unpacking and packing shall be supported where all the entities associated to an alarm can be display in the Monitoring UI with the single click of a button.
- M. The user shall have the ability to acknowledge alarms, create an incident upon alarm acknowledgement, and put an alarm to snooze.
- N. The user shall be able to spontaneously trigger alarms based on something they see in the system.
- O. An alarm shall be configured in such a way that it remains visible until the source condition has been acknowledged.
- P. The user shall be able to investigate an alarm without acknowledging it.

2.23 USP REMOTE TASK

- A. The USP shall provide, through a Remote Task, capabilities to remotely monitor and control the content of other workstations running the CSA (Monitoring UI) that are part of the same system.
- B. The USP shall support video wall applications by connecting and controlling multiple workstations and monitors simultaneously.
- C. The Remote Task shall be a graphical interface showing a replication of the remote workstation running the CSA (Monitoring UI).
- D. The Remote Task shall allow the connection to other workstations using a low bandwidth mode to receive only snapshots of video viewed remotely.
- E. The Remote Task shall allow the connection to other workstations using a spy mode to remain invisible to the remotely connected workstation. The spy mode option should be available to the user with permission to access the feature.
- F. The functionality provided by the remote monitoring and control capability shall include:
 - 1. Remote monitoring and control of the monitoring and alarm monitoring tasks.
 - 2. Ability to remotely switch cameras, doors and zones into display tiles.
 - 3. Ability to remotely control live and playback video.

4. Ability to remotely change the tile pattern.
5. Ability to remotely create and delete tasks.
6. Ability to remotely start/stop task cycling.
7. Ability to remotely go into full screen mode.
8. Ability to remotely save and reload the workspace.

2.24 USP ADVANCED TASK MANAGEMENT

- A. USP shall support an infrastructure for managing Monitoring UI tasks used for live monitoring, day to day activities, and reporting.
- B. Administrators shall be able to assign tasks and lock the operator's workspace. The user management of their workspace shall be limited by their assigned privileges.
- C. Operators shall be able save their tasks as either Public tasks or Private tasks and in a specific partition. Public tasks shall be available to all users. Private tasks shall only be available to the owner of the task.
- D. Operators shall be able to share their tasks by sending them to one or more online users. Recipients shall have the option to accept the sent task.
- E. Operators shall be able to duplicate a task.

2.25 USP REPORTING

- A. The USP shall support report generation (database reporting) for access control, ALPR, video, and intrusion.
- B. Each and every report in the system shall be a USP task, each associated with its own privilege. A user shall have access to a specific report task if they have the appropriate privilege.
- C. The workflows to create, modify, and run a report shall be consistent for access control, ALPR, and video reports.
- D. Reports shall be federated, allowing global consolidated reporting across multiple independent USP, ACS, VMS, and ALPR systems.
- E. Access control and ALPR reports shall support cardholder pictures and license plate pictures, respectively.
- F. The USP shall support the following types of reports:
 1. Alarm reports
 2. Video-specific reports (archive, bookmark, motion, and more)
 3. Configuration reports (cardholders, credentials, units, access rules,

readers/inputs/outputs, and more)

4. Activity reports (cardholder, cardholder group, visitor, credential, door, unit, area, zone, elevator, and more)
5. ALPR-specific reports (mobile ALPR playback, hits, plate reads, reads/hits per day, reads/hits per ALPR zone, and more)
6. Health activity and health statistics reports
7. Other types of reports, including visitor reports, audit trail reports, incident reports, and time and attendance reports

G. Custom Reports and Report Templates:

1. The user shall have the option of generating generic reports from an existing list, generating reports from a list of user-defined templates, or creating a new report or report template.
2. The user shall be able to customize the predefined reports and save them as new report templates. There shall be no need for an external reporting tool to create custom reports and report templates. Customization options shall include setting filters, report lengths, and timeout period. The user shall also be able to set which columns shall be visible in a report. The sorting of reported data shall be available by clicking on the appropriate column and selecting a sort order (ascending or descending).
3. All report templates shall be created within the Monitoring UI.
4. These templates can be used to generate reports on a schedule in PDF or Excel formats.
5. An unrestricted number of custom reports and templates shall be supported.

H. A reporting task layout shall consist of panes with settings (report length, filters, go and reset commands, etc.), the actual report data in column format, and a pane with display tiles. The user shall be able to drag and drop individual records in a report onto one or more display tiles to view a cardholder's picture ID, playback a video sequence, or an ALPR event.

I. The USP shall support comprehensive data filtering for most reports based on entity type, event type, event timestamp, custom fields, and more.

J. The reporting task shall have the ability to display results through graphics such as line charts, bar charts, stacked bar charts, doughnut charts, and pie charts.

K. The user shall be able to click on an entity within an existing report to generate additional reports from the Monitoring UI.

L. The USP shall support the following actions on a report: print report, export report to a PDF/Microsoft Excel/CSV file, export the graphics chart in JPG/PNG, and automatically

email a report based on a schedule and a list of one or more recipients.

M. Shall allow the ability to insert a custom logo when generating reports.

2.26 USP DASHBOARDS

A. The USP shall support the ability to create dashboards.

B. Operators shall be allowed to view dashboards if they are granted the appropriate privilege. Modification to dashboards should also be allowed to users granted the appropriate privilege.

C. Dashboards in the system shall be a USP task. A user shall have access to a specific dashboard task if they have the appropriate privilege.

D. Dashboards shall be saved either in a private folder or a public folder.

E. A dashboard shall consist of a canvas with various widgets displayed on the canvas. All widgets should offer the ability to specify location and size to the widget, a title to the widget, a background color to the widget, and the ability to refresh periodically the content of the widget.

F. Dashboard widget types shall be:

1. Image: provides the ability to display an image (JPG, PNG, GIF, BMP) on a dashboard.

2. Text: provides the ability to display a text on a dashboard. The text style shall be configurable, so font, size, color, and alignment can be specified by the user.

3. Tile: provides the ability to display any entity of the USP inside of a tile.

4. Web page: provides the ability to display a URL on a dashboard.

5. Entity Count: provides the ability to display the total number of a specific entity type in the USP.

6. Reports: provides the ability to display the results of any saved reports in the system. The results shall be displayed either by showing the total number of results in the report, a set of top results from the report, or a visual graph from the data returned by the report.

7. State: based on zones, intrusion areas, reader or input including color coded state and text.

8. Map: Provides the ability to display and interact with maps on a dashboard.

G. It shall be possible to extend to the widgets of a dashboard using the SDK. This will provide the ability to develop custom widgets to the system.

H. The USP shall support the following actions on a dashboard: print dashboard, export dashboard to PNG file, and automatically email a report based on a schedule and a list of

one or more recipients.

2.27 USP ZONE MANAGEMENT

- A. The USP shall support the configuration and management of zones for input point monitoring via the Zone Manager Role. A user shall be able to add, delete, or modify a zone if they have the appropriate privileges.
- B. A zone shall monitor the status of one or more inputs points. Zone monitoring or input point monitoring shall be possible through the use of a controller and one or more input modules. Inputs from video cameras or video encoders shall also be accessible via a zone.
- C. Depending on the hardware installed, supervised inputs shall be supported. Depending on the input module used, both 3-state and 4-state supervision shall be available.
- D. A schedule shall be defined for a zone, indicating when the zone will be monitored.
- E. Custom Events shall provide full flexibility in creating custom events tailored to a zone. Users shall be able to associate custom events to state changes in monitored inputs.
- F. The ACS shall support one or more cameras per zone. Video shall then be associated to zone state changes.
- G. Input/Output (IO) Linking:
 - 1. Zone management shall support Input/Output (IO) Linking. I/O Linking shall allow one or more inputs to trigger one or more outputs.
 - 2. IO Linking shall be available in offline mode when communication between the server and hardware is not available.
 - 3. Custom Output Behaviors shall provide full flexibility in creating a variety of complex output signal patterns: simple pulses, periodic pulses, variable duty-cycle pulses, and state changes.
 - 4. Through the “trigger an output” action, the ACS shall support the triggering of outputs with custom output behaviors.

2.28 USP USER AND USER GROUP SECURITY, PARTITIONS, AND PRIVILEGES MANAGEMENT

- A. The USP shall support the configuration and management of users and user groups. A user shall be able to add, delete, or modify a user or user group if they have the appropriate privileges.
- B. The USP shall support user authentication with claims-based authentication using external providers. External providers shall include:
 - 1. ADFS (Active Directory Federation Services)
 - 2. Azure Active Directory (through OpenID Connect)

3. Ping Identity (through OpenID Connect)
 4. KeyCloak (through OpenID Connect)
 5. Other Open ID Connect / SAML2 authentication agents
- C. Common access rights and privileges shared by multiple users shall be defined as User Groups. Individual group members shall inherit the rights and privileges from their parent user groups. User group nesting shall be allowed.
- D. User privileges shall be extensive in the USP. All configurable entities for the USP, including access control, video, and ALPR shall have associated privileges.
- E. Specific entities, such as cardholders, cardholder groups, and credentials shall include a more granular set of privileges, such as the right to access custom fields and change the activation or profile status of an entity.
- F. Partitions:
1. The USP shall limit what users can view in the configuration database via security partitions (database segments). The administrator, who has all rights and privileges, shall be allowed to segment a system into multiple security partitions.
 2. All entities that are part of the USP can be assigned to one or more partitions.
 3. A user who is given access to a specific partition shall only be able to view entities (components) within the partition to which they have been assigned. Access is given by assigning the user as an accepted user to view the entities that are members of a particular partition.
 4. A user or user group can be assigned administrator rights over the partition.
- G. It shall be possible to specify user and user group privileges on a per partition basis.
- H. Advanced logon options shall be available such as dual logon and more.
- I. It shall be possible to specify an inactive period for the Monitoring UI after which time the application shall automatically lock, while still preserving access to currently displayed camera feeds.
- J. It shall be possible to review user permissions and determine:
1. For any entity in the system, which user group or user can view or modify it.
 2. For any user group or user in the system, what are its privileges.
 3. For any privilege in the system, which user group or user is allowed to perform the underlying action.

2.29 USP EVENT/ACTION MANAGEMENT

- A. The USP shall support the configuration and management of events for video and ALPR.

A user shall be able to add, delete, or modify an action tied to an event if he has the appropriate privileges.

- B. The USP shall receive all incoming events from one or more ACS, VMS, and/or ALPR. The USP shall take the appropriate actions based on user-define event/action relationships.
- C. The USP shall receive and log the following events:
 - 1. System-wide events
 - 2. Application events (clients and servers)
 - 3. Area, camera, door, elevator, and ALPR events (reads and hits)
 - 4. Unit events
 - 5. Zone events
 - 6. Alarm events
 - 7. ALPR events
 - 8. Health Monitoring events
- D. The USP shall allow the creation of custom events.
- E. The USP shall have the capability to execute an action in response to an access control, video, and ALPR event. The USP shall support the following list of actions, without being limited to:
 - 1. Add bookmark
 - 2. Arm intrusion detection area
 - 3. Arm zone
 - 4. Block and unblock video
 - 5. Bypass input
 - 6. Cancel postpone intrusion detection area arming
 - 7. Clear input bypass
 - 8. Clear task
 - 9. Display a camera on an analog monitor
 - 10. Display an entity in the CSA
 - 11. Email a report

12. Email a snapshot
13. Export report
14. Forgives antipassback violation
15. Go home
16. Go to preset
17. Import from file
18. Override recording quality
19. Override with event recording quality
20. Override with manual recording quality
21. Play a sound
22. Postpone intrusion detection area arming
23. Reboot unit
24. Recording quality as standard configuration
25. Rest area people count
26. Reset parking zone inventory
27. Run a macro
28. Run a pattern
29. Send a message
30. Send a task
31. Send an email
32. Set parking zone occupancy
33. Set reader mode
34. Set the door maintenance mode
35. Set threat level
36. Start/Stop applying video protection
37. Start/Stop recording

38. Start/Stop transfer
39. Synchronize role
40. Temporary override elevator schedules
41. Trigger intrusion alarm
42. Trigger alarm
43. Trigger output
44. Trigger read
45. Unlock door explicitly
46. Set the entity maintenance mode
47. Trigger incident
48. Set interface background color
49. Set minimum security clearance

F. The USP shall allow a schedule to be associated with an action. The action shall be executed only if it is an appropriate action for the current time period.

2.30 USP SCHEDULES AND SCHEDULED TASKS

A. Schedules

1. The USP shall support the configuration and management of complex schedules. A user shall be able to add, delete, or modify a schedule if they have the appropriate privileges.
2. The USP shall provide full flexibility and granularity in creating a schedule. The user shall be able to define a schedule in 1-minute or 15-minute increments.
3. Daily, weekly, ordinal, and specific schedules shall be supported.

B. Scheduled Tasks

1. The USP shall support scheduled tasks for video, and ALPR.
2. Scheduled tasks shall be executed on a user-defined schedule at a specific day and time. Recurring or periodic scheduled tasks shall also be supported.
3. Scheduled tasks shall support all standard actions available within the USP, such as sending an email or emailing a report.

2.31 USP MACROS AND CUSTOM SCRIPTS

- A. The USP shall enable users to automate and extend the functionalities of the system through the use of macros or custom scripts for access control, video, and ALPR.
- B. Custom macros shall be created with the USP Software Development Kit (SDK).
- C. A macro shall be executed either automatically or manually.
- D. In the Monitoring UI, a macro shall be launched through hot actions.

2.32 USP DYNAMIC GRAPHICAL MAPS (DGM)

- A. The USP shall support mapping functionality for access control, video surveillance, intrusion detection, ALPR, and external applications.
- B. The USP shall provide a map centric interface with the ability to command and control all the USP capabilities from a full screen map interface.
- C. It shall be possible to span the map over all screens of the USP client station. In the scenario where the map is spanned over all the screens of the USP client station it shall be possible to navigate the map including pan and zoom, and the map's moves shall be synchronized between all screens. Spanning the map over multiple screens must provide the same command and control capabilities than in a single screen display.
- D. The DGM shall support the following file format and protocol for importing map background:
 - 1. PDF
 - 2. JPG
 - 3. PNG
 - 4. Web Tile Map Service (WTMS) and Web Map Service (WMS) defined by the Open Geospatial Consortium (OGC)
 - 5. BeNomad
 - 6. AutoCAD (DWG & DXF)
- E. The DGM shall provide the following online map providers for use as map background and provide the ability to manage their service license if they require one:
 - 1. Google Map, aerial, terrain (Licensed)
 - 2. Bing Map, aerial, satellite, hybrid (Licensed)
 - 3. ESRI ArcGIS (Licensed)
 - 4. OpenStreet Map aerial (Licensed)

5. OVI hybrid
- F. It shall be possible to configure a mixed set of maps made of GIS, online providers, and private imported files and link them together.
- G. The DGM shall provide the ability to display all native entities of the USP including:
1. Cameras, fix, and PTZ
 2. Doors
 3. Camera sequences
 4. Areas
 5. Intrusion areas
 6. Intrusion zones
 7. License Plate Recognition cameras
 8. Digital inputs
 9. Digital outputs
 10. Intercoms
 11. Alarms
 12. Macros
 13. Police Car Patrollers
- H. The DGM shall provide the ability to draw and display information over the map in the form of:
1. Vectoral shapes: lines, rectangles, polygons, ellipse
 2. Pictures
 3. Text
- I. The DGM shall provide the ability to display any type of third-party entities integrated through an SDK.
- J. The DGM shall provide the ability to display layer of information in Keyhole Markup Language (KML) format.
- K. The DGM shall provide the ability to the operator to manage layers of entities displayed over the map, being able to turn them on and off and changing the superposition order.
- L. The DGM shall provide the ability to show or hide camera icons and their field of view

based on the zoom level of the map. The icon size can be optionally set to a fixed size regardless of zoom level.

- M. The DGM shall provide the ability to import data layers from one or more ESRI ArcGIS servers.
- N. The DGM shall provide the operators with the ability to manage layers that are imported from ESRI ArcGIS. The operators shall be able to turn the layers on and off, as well as sort the layers.
- O. The DGM shall offer built-in map data backup and restore for both map background and layers of entities.
- P. The DGM shall provide the ability to import configuration from an external file such as:
 - 1. AutoCAD layer for objects
 - 2. CSV, Excel file
- Q. The DGM shall provide the ability to print a map in the following file formats:
 - 1. PDF
 - 2. PNG
- R. The DGM shall offer failover capabilities.
- S. The DGM shall scale up to several thousands of entities on a single map and hundreds of maps.
- T. The DGM shall provide a means to update a map background without affecting the map object configuration.
- U. The DGM shall offer a user-friendly graphical map designer to configure the maps.
- V. The DGM shall provide a user friendly and intuitive navigation that includes:
 - 1. The ability to create hierarchies of maps to facilitate navigation within and between various sites and buildings.
 - 2. The ability to define favorites for recurrent position recall.
 - 3. The possibility to create links between maps. The map links shall allow the link from one map to multiple maps representing the floors of a building. Navigating between floors of a building shall keep the zoom level of the map.
- W. It shall be possible to monitor the state of entities on the map. It shall be possible to customize the icons of any entities represented on the map.
- X. The DGM shall offer the ability to optionally set a graphical display notification of the motion detection.

- Y. The DGM shall offer a smart selection tool to access the video. By clicking the location the user wants to see, the DGM will automatically select the cameras that can see this location and move the PTZ towards that location. This smart selection tool shall take obstacles into consideration and not display cameras that cannot see the location because of a wall.
- Z. It shall be possible to select a location by drawing a zone of interest on the DGM, and to display all the entities that are part of that zone or interest at once.
- AA. The user shall be able to select and display the content of multiple USP entities on the map in pop-up windows.
- BB. The user shall be able to move, resize, and pan the USP entity pop-up windows to the map.
- CC. It shall be possible to access live and playback video from the map.
- DD. It shall be possible to monitor all entity event notifications from the DGM. Users shall be able to turn notifications on and off per entity.
- EE. The DGM shall offer the ability to fully operate alarm monitoring. It shall be possible to:
 - 1. Center the map on entities related to the alarm.
 - 2. Visualize the Alarm notifications on the map and access the related videos from the map.
 - 3. Trigger and receive alarms.
 - 4. Act on the alarm from the DGM, including acknowledgements, forwarding, and investigation.
 - 5. Visualize that an alarm occurred in an underlying linked map.
- FF. The DGM shall provide the following search capabilities:
 - 1. Search and center by entity name.
 - 2. From the Display of an entity in the USP, locate the entity on the map and offer the ability to select another one close-by.
 - 3. By street address, city, landmark, point of interest (using geocoder license from Google, ESRI, or other provider)
- GG. Any update of map content by an administrator shall be immediately and dynamically pushed to all DGM users.
- HH. The DGM shall provide an intuitive built-in map designer for entity positioning on the map using drag and drop. Any configuration shall be graphic.
- II. It shall be possible to edit and configure multiple map objects at once.
- JJ. All map design modifications shall be logged in an audit trail.

- KK. Various actions shall be available within maps for execution through simple and intuitive double-click, right-click, or drag-and-drop functionality. Examples of actions available through maps shall include unlocking a door and acknowledging an alarm.
- LL. Through the following functionalities, the DGM shall allow the management of USP alarms from the map:
1. Locate on the map entities related to the alarm.
 2. Display entities of the alarm with a specific icon, color, transparency level, and blinking rate.
 3. List, select, and locate alarms.
 4. Auto center the map on the highest priority alarm.
 5. Handle the alarm from the map, including acknowledgement, forwarding, and investigation.
 6. All map containers, such as hotspots or map links, shall reflect the alarm status of the contained entities.
- MM. It shall be possible to add advanced functionality to map objects using the SDK. Any functionality available through the USP SDK shall be available within maps.
- NN. The DGM shall offer lasso tools for:
1. Displaying entities at one location through a single action.
 2. Triggering an action on all entities at one location in a single click.
 3. Editing multiple entities at one location simultaneously.
- OO. The DGM shall allow the display of USP entities selected from the map on a remote monitor (video wall).
- PP. The DGM shall provide the ability to search within the map by entity name.
- QQ. The Contractor shall provide licenses for each entity that is required to be shown on the graphical maps.

2.33 USP DIGITAL EVIDENCE MANAGEMENT SYSTEM (DEMS)

- A. The USP shall support the ability to electronically share video exports with third parties.
- B. The USP shall allow recipients to natively review exported video from a web browser, without the need to install software or browser plugins.
- C. Video exported from the UPS will include the original file and timestamp information, as well as the system, workstation, and camera source metadata that can be viewed from the DEMS.

- D. The USP shall support the ability to create a case within the DEMS, and assign associated incident details, when exporting video.
- E. The USP shall support the ability to publish a list of cameras in a DEMS camera registry.
- F. The USP shall allow for participants in the DEMS camera registry to be displayed on the map of the USP.
- G. The USP shall process video requests originating from the DEMS without requiring operator intervention.
- H. Video requests sent from the DEMS to the USP shall be processed from the following sources:
 - 1. Cameras connected to the USP.
 - 2. Federated cameras connected to the USP.
 - 3. Vehicle and onboard systems connected to the USP.
- I. Video from vehicle and onboard systems sent to the DEMS shall include the following features:
 - 1. Ability to request and playback video from onboard cameras through the web interface of the DEMS.
 - 2. Display of metadata from vehicle sensors such as:
 - (1) GPS coordinates
 - (2) Vehicle triggers
 - (3) Vehicle speed
 - 3. Display of vehicle route on a map through the web interface of the DEMS.

2.34 USP AUDIT AND USER ACTIVITY TRAILS (LOGS)

- A. The USP shall support the generation of audit trails. Audit trails shall consist of logs of operator/administrator additions, deletions, and modifications.
- B. Audit trails shall be generated as reports. They shall be able to track changes made within specific time periods. Querying on specific users, changes, affected entities, and time periods shall also be possible.
- C. For entity configuration changes, the audit trail report shall include detailed information of the value before and after the changes.
- D. The USP shall support the generation of user activity trails. User activity trails shall consist of logs of operator activity on the USP such as login, camera viewed, ALPR event viewed, badge printing, video export, and more.

- E. The ACS shall support the following actions on an audit and activity trail report: print report and export report to a PDF/ Microsoft Excel/CSV file.

2.35 USP INCIDENT REPORTS

- A. Incident reports shall allow the security operator to create reports on incidents that occurred during a shift. Both video-related and access control-related incident reports shall be supported.
- B. The operator shall be able to create standalone incident reports or incident reports tied to alarms.
- C. The operator shall be able to link multiple video sequences to an incident, access them in an incident report, and change the date or time of the sequences later on.
- D. It shall be possible to create a list of Incident categories, tag a category to an incident, and filter the search with the category as a parameter.
- E. Incident reports shall allow the creation of a custom form on which to input information on an incident.
- F. Incident reports shall allow entities, events, and alarms to be added to support at the report's conclusions.

2.36 USP DATA INGESTION

- A. The USP Shall allow the possibility to import external data from outside sources to enhance unification of data sources within the USP.
- B. Each data source shall be defined by a set of fields and field types that describe the data source. Field types shall be:
 - 1. String
 - 2. 32 bit & 64 bit integer
 - 3. Floating point number
 - 4. Boolean
 - 5. Timestamp
 - 6. Binary (in a file or base 64)
- C. The visualization of each data point from a data source shall be configurable to determine what fields from the data should be displayed. The configuration of each field shall be:
 - 1. Which fields are displayed or hidden
 - 2. What order are the fields displayed
 - 3. A label to specify the name of the field (to have a key value format)

4. An option to specify how to display the field (text value, Image, clipboard value, hyperlink to a web page, hyperlink to an entity in the system, sound file)
- D. A privilege should be available for each data source to allow / deny access to specific user & user groups of the USP.
- E. Ingested data shall be available in the USP reporting system.
- F. Ingested data shall be available to display in the USP Dashboards.
- G. Intrusion Detection Integration:
1. The USP shall integrate with third party intrusion panels and devices via an Intrusion SDK. The Intrusion Manager Role shall manage communications with the intrusion panels. Communications with intrusion devices shall be over serial communications and/or an IP network.
 2. Integration with intrusion panels shall be possible outside the release cycle of the USP. It shall be possible to add new integrations at any point in time.
 3. Functionality available via the integration of intrusion devices with the USP shall include the following (where supported by the intrusion panel):
 - a. Arm and disarm intrusion devices (manually, on schedule, or following a USP event).
 - b. Activate or trigger intrusion device outputs.
 - c. View intrusion events and alarms.
 - d. Monitor the status, including arming status, of the intrusion devices.
 - e. Video verification of intrusion events and alarms with video panels.
 - f. Create USP zones using intrusion device inputs.
- H. Third Party Access Control Systems:
1. The USP shall integrate with third party access control software via the SDK. Communications with access control software shall be over an IP network and should not support administrative tasks such as cardholder management.
 2. Integration with access control software shall be possible outside the release cycle of the USP. It shall be possible to add new integrations at any point in time.
 3. Functionality available via the integration of access control software with the USP shall include the following (where supported by the access control solution):
 - a. Synchronize access control entities and receive associated events and states within the USP, including:
 - (1) Visitors

- (2) Readers and doors
- (3) Alarms
- (4) Inputs and outputs
- b. Monitor access control events.
- c. Monitor and Acknowledge access control alarms.
- d. Trigger actions and outputs in the access control software using hot actions and event-to-actions.
- e. Lock and unlock doors in the access control software.
- f. Video verification of access control events and alarms.
- g. Configure event-to-actions using the access control events and alarms.
- h. Generate Security Center reports using from the in the access control data.
- i. View and monitor states of door entities in the USP maps.

2.37 USP SOFTWARE DEVELOPMENT KIT (SDK)

- A. A USP SDK shall be available to support custom development for the platform.
- B. The SDK shall include functionalities specific to the embedded automatic license plate recognition (ALPR), access control (ACS), and video (VMS) systems.
- C. Integration with external applications and databases shall be possible with the SDK.
- D. The SDK shall enable end-users to develop new functionality (user interface, standalone applications or services) to link the USP to third party business systems and applications, such as Badging Systems, Human Resources Management Systems (HRMS), and Enterprise Resource Planning (ERP) systems.
- E. The SDK shall be based on the .NET framework.
- F. The SDK shall support dynamic or transactional updates to the USP configuration. It shall also support change notification of USP entity configuration.
- G. The SDK shall provide an extensive list of programming functions to view and/or configure core entities such as: users and user groups, alarms, custom events, and schedules, and more.
- H. The SDK shall provide an extensive list of programming functions to view and configure ACS, VMS, and ALPR.
- I. The SDK shall provide an extensive list of programming functions to view and configure most ACS entities such as: cardholders, cardholder groups, visitors, credentials, access rules (modify only), and custom fields.

- J. The SDK shall be able to receive real time events from the following USP entities: users and user groups, areas, zones, cameras, video units, doors, door controllers (units), elevators, cardholders, cardholder groups, and credentials.
- K. The SDK shall be able to query the history of events for areas, cameras, zones, alarms, cardholders, credentials, visitors, doors, query license plate read events, license plate hit events, generate a license plate hits report, generate a license plate reads report.
- L. The SDK shall support the following alarm functions: view alarms in real time, acknowledge alarms, change priority, and change recipient.

PART 3 - EXECUTION

3.01 WARRANTY

- A. The product shall perform in all material respects in accordance with the accompanying user manual, and the media on which the Software Product resides will be free from defects in materials and workmanship under normal use. Software defects are covered through Service Releases and Cumulative Updates which are available for a period of 1 year from the date of the software purchase.
- B. Extended warranty, up to 5 years, shall be available through the purchase of the Genetec Advantage support service which includes the following additional services over the standard warranty:
 - 1. Access to phone support and online chat for technical assistance
 - 2. Online case management
 - 3. Online system availability monitor
 - 4. Access to Major and Minor Release Upgrades

3.02 DEPLOYMENT SERVICES AND SYSTEM COMMISSIONING

- A. General Requirements:
 - 1. The contractor shall engage the services of the USP vendor to assist in the management of the deployment of the USP at the end-user site on projects that involve:
 - a. Multiple contractors or subcontractors that will be responsible for deploying the USP at multiple client sites in different geographical regions.
 - b. Complex enterprise installations involving advanced functionality (for example The Federation feature, failover, plugins) and/or multiple systems (for example access control, video, ALPR) and/or third-party integrations.
 - c. Extensive use of customized solutions/plugins developed by the vendor that will be integrated into the USP.

2. The USP vendor services shall include Deployment Management and System Configuration and Commissioning.

B. Deployment Management Service:

1. The Deployment Management service from the vendor shall include a Project Manager acting as the single point of contact for all communications between the contractor and the vendor organization and who will be responsible for:
 - a. Conducting a Risk Assessment of the impact of potential risk factors on the operation of the vendor's USP.
 - b. Providing a project plan for the deployment of the vendor's USP.
 - c. Managing the development and deployment of the custom solution components that will be integrated into the vendor's USP (if applicable).
 - d. Providing a scope of work detailing the services to be provided by the vendor to assist in the deployment of the vendor's USP.
 - e. Coordinating and scheduling the vendor field services with the contractor to assist with the deployment of the vendor's USP.
 - f. Providing regular project status updates to the contractor regarding the development of custom solutions (if applicable) and the deployment of the vendor's USP.

C. Solution Architect Service:

1. The Solution Architect service from the vendor shall include a Solutions Architect Engineer acting as a single technical point of contact throughout the deployment of the USP, and who will be responsible for:
 - a. Assisting the contractor/subcontractor with the design and architecture of the vendor's USP.
 - b. Conducting technical consultation activities that may include fit/gap analysis, system design reviews, device compatibility assessments, functional and technical design reviews as well as performance reviews of the vendor's USP.
 - c. Conducting a system assessment and ensuring best practices of the vendor's USP are followed.
 - d. Providing upgrade and migration strategy for the vendor's USP where applicable.
 - e. Providing documentation regarding the system architecture, system design, hardware specifications and compatibility requirements, camera bandwidth calculations, and best practices as they relate to the vendor's USP.

D. System Configuration and Commissioning Service:

1. The System Configuration and Commissioning service from the vendor shall include a Field Engineer who will be responsible for:
 - a. Assisting the contractor's or subcontractor's onsite/remote technicians with the configuration and commissioning of the vendor's USP at the client site.
 - b. Conducting a test of the USP following the deployment of the system using real-world operator scenarios to ensure optimal system performance.
 - c. Providing the contractor with a Service Report detailing the tasks completed during the deployment of the USP at the client site, as well as any recommendations for improving the performance of the USP that must be implemented by the contractor.
 - d. Providing a knowledge transfer of the vendor's USP to the contractor following the deployment of the USP at the client site.

3.03 MANUFACTURER END USER OPERATOR TRAINING

- A. The contractor shall engage the services of the USP vendor to assist in the end user training of the USP at the end-user site.

END OF SECTION 28 23 00

SECTION 28 23 29
VIDEO SURVEILLANCE SURGE PROTECTOR

PART 1 - GENERAL

1.01 SYSTEM DESCRIPTION

A. General Requirements

1. The specified unit shall be of manufacturer's official product line, designed for commercial and/or industrial 24/7/365 use.
2. The specified unit shall be based upon standard components and proven technology using open and published protocols.

B. Sustainability

1. The specified unit shall be manufactured in accordance with ISO 14001.
2. The specified unit shall be compliant with the EU directives 2011/65/EU (RoHS) and 2012/19/EU (WEEE).
3. The specified unit shall be compliant with the EU regulation 1907/2006 (REACH).
4. The specified unit, including all its components, shall not contain any added PVC.
5. The manufacturer shall have signed and support the UN Global Compact initiative as defined by United Nations.

1.02 RELATED WORK

A. SUMMARY OF WORK: Section 01 11 00:

1. Refer to "PART 2 – PRODUCTS" for all Buy America Build America Act (BABA) Requirements.

1.03 CERTIFICATIONS AND STANDARDS

A. General abbreviations and acronyms

1. AGC: Automatic gain control
2. AES: Advanced Encryption Standard
3. API: Application Programming Interface
4. Aspect ratio: A ratio of width to height in images
5. Bit Rate: The number of bits/time unit sent over a network

6. Bonjour: Enables automatic discovery of computers, devices, and services on IP networks.
7. DHCP: Dynamic Host Configuration Protocol
8. DNS: Domain Name System
9. EIS: Electronic Image Stabilization
10. FPS: Frames per Second
11. FTP: File Transfer Protocol
12. H.264 (Video Compression Format)
13. HSMS: Hosted Security Management System (SaaS PACS Application)
14. IEEE 802.1x: Authentication framework for network devices
15. IP: Internet Protocol
16. IR light: Infrared light
17. ISO: International Standards Organization
18. JPEG: Joint Photographic Experts Group (image format)
19. LAN: Local Area Network
20. LED: Light Emitting Diode
21. LPR: License Plate Recognition
22. Lux: A standard unit of illumination measurement
23. MBR: Maximum Bit Rate
24. MPEG: Moving Picture Experts Group
25. Multicast: Communication between a single sender and multiple receivers on a network
26. NTP: Network Time Protocol
27. NTSC: National Television System Committee – a color encoding system based on 60Hz
28. ONVIF: Global standard for the interface of IP-based physical security products
29. PACS: Physical Access Control System
30. PAL: Phase Alternating Line – a color encoding system based on 50Hz

31. PoE: Power over Ethernet (IEEE 802.3af/at) standard for providing power over network cable
 32. Progressive scan: An image scanning technology which scans the entire picture
 33. PTZ: Pan/Tilt/Zoom
 34. QoS: Quality of Service
 35. RAID: Redundant Array of Independent Disks
 36. RPC: Remote Procedure Call
 37. SaaS: Software as a Service
 38. SIP: Session Initiation Protocol
 39. SMTP: Simple Mail Transfer Protocol
 40. SMPTE: Society of Motion Picture and Television Engineers
 41. SNMP: Simple Network Management Protocol
 42. SSL: Secure Sockets Layer
 43. TCP: Transmission Control Protocol
 44. TLS: Transport Layer Security
 45. Unicast: Communication between a single sender and single receiver on a network
 46. UPnP: Universal Plug and Play
 47. UPS: Uninterruptible Power Supply
 48. VBR: Variable Bit Rate
 49. VMS: Video Management System
 50. WDR: Wide dynamic range
- B. The specified unit shall meet the following product safety standards:
1. UL 497B
- C. The specified unit shall meet the following standards
1. Mechanical Environment:
 - a. IEC/EN 60529 IP66 (Ingress protection)
 - b. NEMA 250 Type 4X

2. Surges immunity standards:

- a. IEC 61643-21
- b. GR1089
- c. ITU-T K.45

1.04 QUALITY ASSURANCE

- A. The contractor or security sub-contractor shall be a licensed security Contractor with a minimum of five (5) years' experience installing and servicing systems of similar scope and complexity and evidence that is completed at least three (3) projects of similar design and is currently engaged in the installation and maintenance of systems herein described.
- B. All installation, configuration, setup, program and related work shall be performed by electronic technicians thoroughly trained by the manufacturer in the installation and service of the equipment provided.
- C. The contractor or designated sub-contractor shall submit credentials of completed manufacturer certification, verified by a third-party organization, as proof of the knowledge.
- D. The specified unit shall be manufactured in accordance with ISO9001.

1.05 WARRANTY

- A. The manufacturer shall provide a five (3) year limited hardware warranty for product that is free from defects in design, workmanship and materials under substantiated normal use. Defective products under the warranty period will be either repaired or replaced by the manufacturer.

PART 2 - PRODUCTS

2.01 GENERAL

- A. Units shall be IP-based and comply with established network and video standards.

2.02 VIDEO SURVEILLANCE SCHEDULE

- A. Unit types listed below describing various resolutions, form-factor and features shall be supplied by a single surge manufacturer video surveillance system.
- B. The unit manufacture and model numbers will be as follows:
 - 1. Ethernet surge protector shall be AXIS T8061

2.03 VIDEO SURVEILLANCE UNITS

- A. Ethernet surge protector
 - 1. The surge protector shall meet or exceed the following design specifications:

- a. The surge protector shall be designed to protect up to 10 kV surge.
- b. The surge protector shall provide a surge handling capability of 10 kV, 5 kA to ground in 8/20 μ s.
- c. The surge protector shall be designed to support data rates up to 1000 Mbps.
- d. The surge protector shall have an MTBF of 400,000 hours operating at 25°C (77°F).
- e. Hardware interfaces
 - (1) Network interface
 - The surge protector shall be equipped with two shielded RJ45 10BASE-T/100BASE-TX/1000BASE-T PoE Ethernet ports.
 - (2) Grounding
 - The surge protector shall be equipped with a GND screw.
- f. Enclosure
 - (1) The surge protector shall:
 - Be manufactured with a weatherproof metal casing.
 - Be designed for wall or pole mounting.
- g. Power
 - (1) Input power: 95 W (maximum)
 - (2) Input Current: 2 A (maximum)
- h. Environmental
 - (1) operate in a temperature range of -40°C to +85°C (-40°F to +185°F).
 - (2) operate in a humidity range of 0-95% RH (non-condensing).

PART 3 - EXECUTION

3.01 INSTALLATION

- A. The contractor's or subcontractor's main resources within the project shall carry proper professional certification issued by the manufacturer and verified by a third-party organization to confirm sufficient product and technology knowledge.
- B. The contractor shall carefully follow instructions in documentation provided by the manufacturer to ensure all steps have been taken to provide a reliable, easy-to-operate

system.

- C. All equipment shall be tested and configured in accordance with instructions provided by the manufacturer prior to installation.
- D. All firmware found in products shall be the latest and most up-to-date version as specified by the manufacturer, or by the product component provider.
- E. All equipment requiring users to log on using a password shall be configured with user/site-specific password/passwords. No system/product default passwords shall be allowed.
- F. A proper installation shall meet NEC (National Electrical Code – US only) per the guidelines of that year’s revision. When properly installed equipment meets Low Voltage, Class 2 classification of the NEC.

END OF SECTION 28 23 29

SECTION 28 31 11
DIGITAL ADDRESSABLE FIRE ALARM SYSTEM

PART 1 – GENERAL

1.01 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and other related specification sections, apply to work of this section.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00.
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) requirements.

1.03 SECTION INCLUDES

- A. An addressable fire alarm and smoke detection and supervisory system.

1.04 REFERENCES (FIRE ALARM SHALL COMPLY WITH THE FOLLOWING)

- A. 8th Edition of the Florida Fire Prevention Code including NFPA 101 - Code for Safety to Life from Fire to Buildings and Structures, Florida Specific Edition.
- B. 8th Edition of the Florida Building Code (2023).
- C. NFPA 70 - National Electrical Code, 2020
- D. NFPA 72 - National Fire Alarm Code, 2019.
- E. NFPA-75 – Standard for the Protection of Information Technology Equipment, 2009
- F. NFPA-2001 – Standard on Clean Agent Fire Extinguishing Systems, 2020
- G. Refer to Specification Sections 21 22 00 and 21 13 16

1.05 REGULATORY REQUIREMENTS

- A. System: UL listed.
- B. Conform to requirements of the Florida Fire Prevention Code and the State Fire Marshall.

1.06 DESCRIPTION OF SYSTEM

- A. The system shall be an addressable, microprocessor based fire alarm control system with transient protection on each circuit and walk-through test capability. The system shall have the capability to control and supervise all the addressable devices and non-addressable appliance and auxiliary control circuits. Each component of the system shall be UL listed for its use. The system shall have a Dynamic LCD display and be located in a constantly attended location while the building is occupied. The system shall monitor

all other fire protection systems, including the clean agent systems, dry pipe pre-action system and fire sprinkler system. The system shall be completely new.

1.07 QUALIFICATIONS

- A. Manufacturer: Company specializing in smoke detection and fire alarm systems with twenty (20) years documented experience.
- B. Installer: Company specializing in smoke detection and fire alarm systems with ten (10) years documented experience with projects of equivalent scope of work and size and certified by the Florida State Licensing Board as fire alarm installing contractor. The actual installer shall be licensed in Florida to install fire alarm systems and shall be certified by the system manufacturer to install the system. Proof of certification and licensure shall be provided upon request.

1.08 SUBMITTALS

- A. Submit six (6) copies shop drawings and product data.
- B. Provide complete point to point wiring diagrams, data sheets, and equipment ratings, layout, dimensions, and finishes. Indicate the location of surge protection devices.
- C. Submit manufacturer's installation instructions.
- D. Submit manufacturer's certificate that the system meets or exceeds specified requirements - certification per NFPA 72.
- E. Submit copy of Contractor's license before work begins.
- F. Submit battery calculations indicating the required battery, including the specified spare capacity.
- G. Submit voltage drop calculations.
- H. Provide training for four (4) people on the operation, maintenance, and repair of the system at the Contractor's expense. Training shall be certified by the manufacturer and be at different dates and times for two different sessions. Include transportation, room and board if travel is required.

1.09 PROJECT RECORD DRAWINGS

- A. Contractor shall provide five (5) sets of as-built drawings to the Owner upon completion of project.
- B. As-builts shall include the location of end-of-line devices, surge protection devices and exact conduit and wire routing. Numbers and types or conductors shall be indicated for each circuit.

1.10 OPERATION AND MAINTENANCE DATA

- A. Provide seven (7) copies of operation and maintenance data prior at the completion of construction for all point devices, CPUs, and all other equipment.

- B. Include operating instructions, and maintenance and repair procedures.
- C. Provide manufacturer representative's letter stating that the system is operational.
- D. Provide a CD with a copy of the final programming, including any software access codes necessary for the Owner to access the required program for maintenance using authorized personnel.

1.11 DELIVERY, STORAGE, AND HANDLING

- A. Products shall be delivered to job site in manufacturers original shipping packages.
- B. Provide storage and protection of products, as needed.

1.12 SPECIAL REQUIREMENTS

- A. The Fire Alarm System herein specified shall be furnished by a manufacturer of Fire Alarm Systems who has been conducting business in the general Escambia County area for at least five (5) years. A complete stock of parts for the systems furnished shall be in inventory at the facilities of the supplier. The equipment manufacturer shall have service facilities within a one hundred (120) mile radius of the building with parts in stock and trained service personnel and shall respond to a service call within twenty-four (24) hours after request during the warranty period (four (4) hours for an emergency request).
- B. Installation to be performed only by Manufacturer's authorized, trained, and licensed installer.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with all of the contract documents, manufacturers offering products that meet the requirements of these specifications may be considered.

- 1. Notifier Onyx series or Edwards EST series, or current model.

NOTE: Manufacturer's equipment shall meet all code requirements and performance criteria as outlined in the contract documents, including all code requirements.

2.02 FIRE ALARM CONTROL PANEL (FACP)

- A. The system shall be an addressable, microprocessor based fire alarm control system with transient protection on each circuit and walk-through test capability. The system shall have the capability to control and supervise all the addressable devices and non-addressable appliance and auxiliary control circuits. Each component of the system shall be UL listed for its use. The system shall have a Dynamic LCD display in plain english language. Control panel construction shall be modular with solid state, microprocessor based electronics and shall conform to all requirements made necessary by the State Fire Marshall. It shall display only those primary controls and displays essential to operation during a fire alarm condition. Keyboards or keypads shall not be required to operate the system during fire alarm conditions. A local audible device shall sound during alarm, trouble or supervisory conditions. This audible device shall sound differently during each condition to distinguish one (1) condition from another without having to view the panel.

This audible device shall also sound during each keypress to provide an audible feedback to ensure that the key has been pressed properly. The panel shall be complete with all required cards for the points necessary for all the devices indicated. Provide the necessary hard wired circuits for all the indicating appliance and auxiliary control devices. Provide the necessary supervised auxiliary control relays for all monitoring and control requirements. Provide a disable switch for system speakers at the Fire Alarm Control Panel. Label switch 'ALARM SILENCE SWITCH'. (If the switch is left in the disable position during normal system operation, a trouble signal shall sound at the control panel.).

1. Provide a semi-recess mounted cabinet with a hinged, lockable front door.
2. Provide a minimum of 8 amps of power supply/battery charging current.
3. Expansion Capability & Spare Capacity: The control panel shall have the capability for a minimum of 254 addressable points without the requirement for an additional cabinet. Provide the capability to add a minimum of two future indicating appliance circuits in the control panel.
4. Fire alarm annunciator (FAA): Provide an annunciator panels where indicated on the drawings. The FAA shall annunciate all functions of the fire alarm system. The FAA shall identify in plain English language all alarms, troubles, and supervisory alarms. The FAA shall be capable of silencing the alarms.

B. The following primary controls shall be visible through a front access panel:

1. Eighty character liquid crystal display. Individual red system alarm LED.
2. Individual yellow supervisory service LED. Individual yellow trouble LED.
3. Green "power on" LED.
4. Alarm acknowledge key.
5. Supervisory acknowledge key.
6. Trouble acknowledge key.
7. Alarm silence key.
8. System reset key.
9. Printer Board.

C. The control shall provide the following:

1. Setting of time and date.
2. LED testing. Alarm, trouble, and abnormal condition listing.
3. Enabling and disabling of each monitor point separately.
4. Activation and deactivation of each control point separately.
5. Changing operator access levels.
6. Walk test enable.
7. Running diagnostic functions.
8. Displaying software revision level.
9. Displaying historical logs.
10. Displaying card status.
11. Point listing.
12. Indicating appliance silence switch.

D. For maintenance purposes, the following lists shall be available from the point lists menu.

1. All points listed by address.
2. Monitor point list.
3. Signal/speaker list.

4. Auxiliary control list.
5. Feedback point list.
6. Pseudo point list.
7. LED/switch status list.

2.03 INITIATION DEVICES AND ACCESSORIES - ADDRESSABLE

- A. Manual Pull Station: Semi-flush mounted, supervised, normally open single action, addressable type manual pull station. Manual stations shall be single action and shall be constructed of impact resistant lexan with raised white lettering and a smooth high gloss finish. The station shall have a hinged front with key lock. Stations which utilize screwdrivers, Allen wrenches, or other commonly available tools shall not be accepted. Stations shall be keyed alike with the fire alarm control panel. When the station is operated, the handle shall lock in a protruding manner to facilitate quick visual identification of the activated station.
- B. Heat Detector: Easy installation, low profile with wide base to cover mounting plate and box. Detectors shall be white and shall be self-restoring operation. Detectors shall be a combination rate of rise/fixed temperature with thermostats rated at 135 degrees F, except when the plans call for a 194 or 200 degrees F rating (HT). Rate of rise setting shall be selectable at either 15 degrees F per minute or 20 degrees F per minute, factory set at 15 degrees F. The detector shall be the addressable type for use with an addressable system and shall be UL 521 listed for this purpose.
 1. Heat detectors installed in hazardous environments shall be the explosion proof type.
- C. Smoke Detectors: NFPA 72; photoelectric type with plug-in base, supervised visual indication of detector actuation, suitable for mounting on four inch (4") outlet box.
 1. Detectors shall be listed to U.L. Standard 268 and shall be documented compatible with the control equipment to which it is connected. Detectors shall be listed for this purpose by Underwriters Laboratories, Inc. The detectors shall obtain their operating power from the fire alarm panel supervised detection loop. The operating voltage shall be 24 VDC (nominal). Removal of the detector head shall interrupt the supervisory circuit of the fire alarm detection loop and cause a trouble signal to be generated at the control panel. Detectors shall be the addressable type for use on an addressable type system.
 2. Each detector shall have a flashing status indicating LED for visual supervision. When the detector is actuated, the flashing LED will latch on steady and at full brilliance. The detector may be reset by actuating the control panel reset switch.
 3. To minimize nuisance alarms, voltage, EMI and RF transient suppression techniques shall be employed as-well-as a smoke verification circuit and an insect screen. The detector design shall provide full solid-state construction and compatibility with other normally open fire alarm detection loop devices (heat detectors, pull stations, etc.). The detector head shall be easily disassembled to facilitate cleaning.
 4. Smoke Detector Sensitivity Adjust: Means shall be provided for adjusting the sensitivity of any or all analog intelligent smoke detectors in the system from the System keypad or from the keyboard of the video terminal. Sensitivity range shall be within the allowed UL window. The detector shall employ automatic environmental compensation.

5. Alarm Verification: Each of the Intelligent/Addressable Smoke Detectors in the system may be independently selected and enabled to be an alarm verified detector. The Alarm Verification Function shall be programmable from 5 to 50 seconds and each detector shall be able to be selected for verification during the field programming of the system, or anytime after system turn-on. The Alarm Verification shall not require any additional hardware to be added to the Fire Alarm Control Panel. The FACP shall keep a count of the number of times that each detector has entered the verification cycle. These counters may be displayed and reset by the proper operator commands.
- D. Duct Mounted Smoke Detectors: Duct mounted smoke detectors shall be of the solid state photoelectric type and shall operate on the light scattering photodiode principle. The detectors shall be the same as the smoke detectors described in Section 2.03, C., above. Detectors shall be 4 wire operation, addressable type for use on an addressable type system. The detectors shall be mounted in a duct housing with an integral red LED which shall pulse continuously to indicate power on and glow continuously to indicate alarm or sensor trouble condition. The detectors shall be designed to ignore invisible airborne particles or smoke densities that are below the factory set alarm point. No radioactive materials shall be used. Detectors shall be provided with the capability of performing automatic fan shutdown either directly from the detector or via the main control panel.
1. Provide a remote alarm indicator for each duct mounted smoke detector.
 2. Provide a sampling tube sized for the required duct width and rated for the air velocity present in the duct.
 3. Provide control relays and control circuit for air handler shutdown.
 4. Provide detectors in supply and return air streams of each air handler over 2,000 cfm.

2.04 INDICATING APPLIANCES AND ACCESSORIES

- A. Speakers/Horns: Where indicated on the drawings provide moisture repellent, fire retardant horn/speaker designed for smooth frequency response with minimal distortion. Speakers shall be listed and approved for use as a fire alarm indicating appliance. Speakers shall all sound the same general alarm and shall meet all NFPA requirements. Outdoor speakers shall be weatherproof, installed in a weatherproof outlet box, and listed for use as an outdoor fire alarm indicating appliance.
1. Sound Level: 87 dB at 10 feet not to exceed 120 dB. Provide higher dB levels if necessary for the ambient noise level.
 2. Provide speakers throughout the facility to provide for audibility, as required to meet NFPA.
 3. Speaker enclosures shall be white in color.
- B. Visual Flashing Lamps (Xenon Strobe): Visual indicating appliances shall be comprised of xenon flashtube and be entirely solid state. These devices shall be UL listed and be capable of either ceiling or wall mounting. The lexan lens shall be pyramidal in shape to allow better visibility. Separate alarm indicating circuits shall be provided for strobes. The maximum strobe pulse duration shall be 0.2 seconds with a maximum duty cycle of 40 percent. The intensity shall be selected to meet the NFPA requirements and the flash rate shall be at least 1 Hz but not to exceed 3 Hz. In all cases strobe must meet current Department of Justice's Americans with Disabilities Act (ADA) Standards for

Accessibility (ADAS) and NFPA requirements. Provide synchronized strobes where required by NFPA-72.

1. Strobe enclosures shall be white in color.
- C. Audio/Visual Alarm Indicating Appliance: Audio/Visual units shall provide a common enclosure for the fire alarm audible and visual alarm devices. The housing shall be designed to accommodate either horns, bells, chimes, or speakers. The unit shall be complete with a tamper resistant, pyramidal shaped lexan lens with "Fire" lettering visible from a 180 degree field of view. The front panel or bezel which is constructed of cast metal maybe inverted so that the lens is below the audible device. The lamp assembly shall incorporate a built-in reflector for more efficient light propagation and a special shock-mounting arrangement to resist Bulb failure due to vibration. Lamp shall be provided with a 4 wire connection to insure properly supervised in/out system connection. Unit shall be complete with all mounting hardware including backbox. Audio/Visual unit shall be UL Listed for its intended purpose. The audible appliance and visual flashing lamps shall meet the specification indicated above in Parts A and B.
1. Combination speaker/strobes shall be white in color.

2.05 MISCELLANEOUS DEVICES AND ACCESSORIES

- A. Relays and Control Modules for auxiliary control: Provide auxiliary control relays or control modules for door release, end of line supervision and other required control functions indicated on the drawings or otherwise specified. All auxiliary control circuits shall be indicated on the annunciator as a separate zone or shall be addressable using a monitor module so the device can be identified quickly and accurately.
- B. Provide wall mounted, magnetic door holder/automatic door release devices. Door holder shall have a minimum 25 lbs. holding force. Provide variable stem length coordinated with the door requirements.
- C. Monitor Module (Individual Addressable Module)
1. Addressable Monitor modules shall be provided to connect one supervised circuit of a conventional alarm or trouble initiating device (any N.O. dry contact device), such as tamper switches and water flow switches, etc., to the Fire Alarm Control Panel.
 2. The Monitor Module shall mount in a 4-inch square, 2-1/8" deep electrical box.
 3. The conventional alarm initiating device may be wired for Style D or Style B operation. The Monitor module shall provide address-setting means using decimal switches and shall also store an internal identifying code that the Fire Alarm Control Panel shall use to identify the type of device. Modules that use binary jumpers or dip-switches are subject to installation errors are not acceptable. An LED shall be provided that shall flash under normal conditions, indicating that the Monitor module is operational and in regular communication with the control panel.
 4. For difficult to reach areas, the Monitor Module shall be available in a miniature package and shall be no larger than 2-3/4" x 1-1/4" x 1/2". This version need not include Style D or an LED.

- D. Provide all required supervised control circuits for air handler shutdown. Provide a remote indicator whenever the duct mounted detector is concealed from view. Remote indicator shall be located in an accessible and readily visible location.
- E. Provide for fire/smoke damper control for dampers in the UPS Room, Data Visualization spaces, and Server/Bench Test spaces.
- E. Provide supervised monitoring circuits of all sprinkler system water flow switches and tamper switches.
 - 1. Provide valve tamper switch monitoring circuit on the exterior fire protection system backflow assembly on the site. Provide surge suppression device on this circuit.
- F. Connections to security system access controls: Provide the necessary circuits and controls to release access controlled doors where required by NFPA. Coordinate requirements with the access control system for the control circuit location and connections. Coordinate with door hardware specifications.
- G. Sound System Mute: Provide control circuits to mute all local sound systems upon the initiation of a fire alarm, including all training room audio enhancement, paging, music, intercom, etc. Coordinate all requirements with the sound system supplier/installer.
- H. Provide all required monitoring, supervision and controls for all of the clean agent fire suppression systems. Refer to clean agent system specifications for coordination of smoke detector requirements, and control requirements.

2.06 BATTERY BACK-UP

- A. The system shall be battery back-up for 24 hours plus five (5) minutes of alarm capabilities after a 24 hour standby period (per NFPA 72) with all system indicating appliances operating, including strobes, plus 30% spare capacity. Batteries shall be completely sealed, rechargeable type and maintenance free.

2.07 LIGHTNING PROTECTION

- A. Provide surge suppression devices on each initiating device loop and each indicating appliance circuit.
- B. Provide lightning protection on the 120 volt power circuit to the control panel main power supply.
- C. All lightning protection shall be manufactured and listed for use with the fire alarm system by the fire alarm system manufacturer. Devices shall be terminal strip mounted and shall be mounted in a terminal cabinet separate from the control panel, as required to meet UL requirements.
- D. Lightning protection devices shall be UL listed. The clamping voltage shall be coordinated with the system voltage to avoid nuisance clamping. Devices found to clamp too quickly shall be replaced.

2.08 DIGITAL ALARM COMMUNICATOR TRANSMITTER (DACT)

- A. Provide automatic digital monitoring and signaling capability for connection of the fire alarm control panel to a remote monitoring company. The DACT may be internal to the FACP or separate. Provide conduit and cabling from the fire alarm control panel to the DACT in order to transmit all trouble and alarm conditions. Provide the required two dedicated telephone lines from the MDF directly to the FACP for monitoring the DACT. Provide the required 120 volt power circuit. Coordinate connection and remote monitoring requirements with Owner/Design Builder telecommunications personnel.
- B. IP and fire alarm communicator with built-in dialer shall be Honeywell Model #IPGSM-4G
- C. Cellular antenna (outdoor) shall be Honeywell Model #CELL-ANT3DB
- D. Antenna adapter cable shall be Honeywell WA7626-CA
- E. RF Extension Cable Hex Crimp shall be Honeywell 7626-50HC
- F. The communicator shall annunciate all alarms, trouble signals, and supervisory signals to the remote monitoring location as a point-to-point address with the description of the device and the location by building and room number.

2.09 FIRE ALARM CABLE

- A. All fire alarm conductors shall meet the requirements of the local fire marshal and the National Electrical Code. All conductors shall be installed in conduit.
- B. Underground fire alarm circuit are not permitted, except for the circuit to the backflow preventer. This cabling shall be rated for underground, water-tight use and be an “aqua-seal” type cable.

2.10 CLEAN AGENT FIRE SUPPRESSION

- A. Provide all required control and monitoring interface with the clean agent fire suppression system. Refer to specification 21 2200 and provide all required power, fire alarm wiring, and fire alarm control. Provide control of all dampers as required to close and seal the room in alarm. Provide indication of all supervisory, trouble, and alarm signals from the clean agent panels.
- B. Monitor the clean agent panels for alarm, trouble, and supervisory. All smoke detection in the clean agent spaces shall be provided as a part of the clean agent system, per specification 21 2200, with the exception of the fire alarm system smoke detector above the clean agent panel. Provide the smoke detector above the clean agent control panel.

2.11 PRE-ACTION SPRINKLER SYSTEM

- A. Provide all required control and monitoring interface with the pre-action fire suppression system. Refer to specification 211316 and provide all required power, fire alarm wiring, and fire alarm control, including the following:

1. Ceiling mounted heat detectors. These detectors shall be building fire alarm system detectors and connected to the fire alarm control panel. These detectors shall initiate the first phase of the pre-action system.
2. Heat detectors under-raised floor areas. These detectors shall be building fire alarm system detectors and connected to the fire alarm control panel. These detectors shall initiate the first phase of the pre-action system.
3. Supervise the air compressor status.
4. Monitor the pre-action control panel(s) for alarm, trouble and supervisory signals.
5. Provide 120 power for pre-action panel.

2.13 EMERGENCY POWER OFF (EPO) MONITORING AND CONTROL

- A. Provide all required monitoring and control for EPO buttons that are controlling the UPS power and AHU power shut-down for all of the rooms utilizing the clean agent fire suppression system, in accordance with NFPA-75. EPO circuit monitoring shall be supervised and shall provide for status indication.

PART 3 - SEQUENCE OF OPERATION

3.01 ENTIRE BUILDING

- A. All pull stations, heat detectors, smoke detectors, fire sprinklers, and pre-action control panel alarm activation (water flow) shall, when placed in an alarm mode, sound the building general alarm, flash strobe lights, shutdown AHUs, release door holders, release access controlled doors, and annunciate the address of the initiating device to the FACP.
 1. Activate all programmed indicating appliance circuits until silenced.
 2. Actuate all programmed strobe units until the panel is reset.
 3. Annunciate the active initiating devices.
- B. All pull stations, heat detectors, smoke detectors, and duct smoke detectors shall, when placed in a trouble mode, indicate the address of the device experiencing trouble to the FACP.
- C. Duct smoke detectors shall be interlocked to shutdown their respective units on alarm. The shutdown circuit shall be supervised and controlled directly from the FACP.
- D. Clean agent panels shall initiate a supervisory alarm at the FACP when a clean agent system is in alarm mode or trouble mode. Provisions shall be made to re-program clean agent alarm to sound the building alarm, if required by the AHJ.
- D. Provide all required release of doors and other required auxiliary functions.
- F. Provide all additional control functions required by Florida Building Code and the Florida Fire Prevention Code.
- G. Refer to sequence of controls on the drawings for more requirements. Modify the sequences in the field if directed by the fire marshal.

PART 4 - PROGRAMMING

- 4.01 The system shall be fully programmed and completely operational prior to acceptance. The FACP and CPU shall have the capability to be fully programmable by Owner's personnel or Owner's separate vendor under contract to maintain the system. Provide all necessary software access to the owner for re-programming by the owner. Provide all required programming and re-programming for all inspections and final acceptance by the owner, engineer, and fire marshal at no additional cost to the owner, including revisions and modifications to the sequences.
- 4.02 The Manufacturer shall provide the necessary documentation and training to allow the Owner's personnel to maintain and change software.
- 4.03 Program data shall be stored in non-volatile memory with battery back-up. Program data shall not be lost due to temporary outages, surges, dips, etc.

PART 5 - EXECUTION

5.01 INSTALLATION OF FIRE ALARM AND DETECTION SYSTEMS

- A. Install fire alarm and detection systems as indicated, in accordance with equipment manufacturer's written instructions and complying with applicable portions of NEC and NECAs "Standard of Installation" and NFPA-72.
- B. Wiring Systems and Materials
 - 1. Wiring shall be in accordance with requirements of the National Electrical Code and NFPA Regulation 72. The fire alarm system, including components, conduit, boxes and wiring shall be completely installed and wiring and conduit shall be properly tagged and color coded. The Electrical Contractor shall make final connections as shown and required by the equipment manufacturer's wiring instructions.
 - 2. Wiring shall be color coded as follows:
- C. New Systems
 - 1. Manual Stations, Smoke & Heat Detectors: Orange
(Black/Red)
 - 2. Horns & Flashing Lights: Yellow/ Blue
(Blue/White)
 - 3. Smoke Detector Power: Red & Black
 - 4. Door Holders: White
(Purple/Yellow)
 - 5. All Shutdown Circuits (AHU's, Valves, etc.): Purple
(Orange/Brown)
 - 6. Control Panel Power: Black/White
- D. All wire shall be terminated with crimp type open-end spade lugs using tool approved by plug manufacturer. Wire terminating at the control panel or terminal cabinets shall be identified as to circuit and use.
- E. Wiring run to terminal cabinets shall terminate on barrier-type terminal strips. Wire nuts are not acceptable.

- E. All wiring to be installed in conduit with continuous ground. Free-wired cabling is not permitted. Conduit shall be spot painted red and all junction boxes shall be painted red.
- F. All junction box covers shall be painted red. All lengths of conduits shall have at least one red stripe.
- G. AHU shutdown relays and equipment control relays shall be mounted within three (3) feet of controlled device. AHU shutdown relays shall be wired on a separate circuit.
- H. Visual flashing lamps and speakers shall be wired on alternate circuits to provide coverage in the event of the failure of one circuit. Provide the required number of circuits for the indicated number of alarm indicating devices.
- I. Provide conduit, wire and circuit breakers to connect fire alarm control panels to a dedicated circuit. The fire alarm circuit breaker shall be accessible to authorized personnel only and shall be marked FIRE ALARM CIRCUIT CONTROL. Provide handle lock for circuit breaker handle. Paint the handle tie red.
- J. Air handler shutdown shall be controlled from the main Fire Alarm Control Panel. A disconnect switch shall be provided as part of the Fire Alarm Control Panel to allow testing of the system without disruption of air conditioning service or to operate air handlers when system cannot be quickly restored to normal. When the disconnect switch is in the disconnect position, a disarrangement trouble signal shall continue to sound at the panel until the switch is restored to normal. Each panel shall incorporate required modules for air handler shutdown whether or not air handlers exist so that no modifications or additions shall be required for shutdown of air handlers installed in the future. Label switch "FAN DISCONNECT".

5.02 QUALITY ASSURANCE

- A. NEC Compliance comply with NEC as applicable to construction and installation of fire alarm and detection system components and accessories.
- B. UL Compliance and Labeling - Provide fire alarm and detection system components which are UL listed and labeled. Installation is to be by a UL listed installer.
- C. Misc. compliance - The fire alarm system is to be installed in accordance with the equipment manufacturer's written instructions and comply with all applicable portions of the NECAs "Standard Installation" and all local codes and ordinances.

5.03 FIELD QUALITY CONTROL

- A. Inspect relays and signals for malfunctioning, and where necessary adjust units for proper operation to fulfill project requirements. Any fine adjustment shall be performed by specially trained personnel in direct employ of manufacturer of the fire alarm detection system equipment. The Manufacturer's representative shall perform a quality inspection off the final installation and, in the presence of the Electrical Contractor, Architect-Engineer, and Owner's Representatives, shall perform a complete functional test of the system. A system certification verifying the proper system operation shall be required prior to acceptance by the Owner.

5.04 SYSTEM GUARANTEE

- A. All components, parts, and assemblies supplied by the Manufacturer shall be guaranteed against defects in materials and workmanship for a period of twelve (12) months commencing the date of substantial completion. Warranty service shall be provided by a qualified factory trained representative of the equipment manufacturer. Service response time shall be a maximum of four (4) hours before arrival to site.
- B. Testing: The Contractor shall perform all electrical and mechanical tests required by the equipment manufacturer's form and National Fire Protection Association - 72. All test and report costs shall be in the contract price. A checkout report shall be prepared by the installation technicians and submitted in triplicate, one (1) copy of which will be registered with the equipment manufacturer. The report shall include, but not be limited to:
1. A complete list of equipment installed and wired.
 2. Indication that all equipment is properly installed and functions and conforms with these specifications.
 3. Test result of individual initiating devices and indicating appliances.
 4. Serial numbers, locations by zone and model number for each installed detector.
 5. Response time on thermostats and flame detectors (if used).
 6. Technician's name, certificate number and date.
 7. System will not be accepted until this certification is received.
- C. Documentation: After completion of the tests and adjustments listed above, the Contractor shall submit the following information to the Owner.
1. A copy of the test report described in this specification and a Certificate of Compliance prepared as per National Fire Protection Association Standard 72, and State Fire Marshal's Rule 4A-48 to be complete at final test.
 2. Affixed to FACP a standard service tag, as described in rule 4A-48 for fire alarm contractors by the Office of the State Fire Marshal.
 3. Final tests and inspection shall be held in presence of the Owners' representatives and to their satisfaction. The Contractor shall supply personnel and required auxiliary equipment for this test without additional cost to the Owner.
 4. To assure that wire size, power supply, number of devices on a circuit, etc. are suitable to support 100% of devices being in alarm or operated simultaneously, this test shall include the following:
 - a. Place all sensors and monitor modules in alarm. Each shall display it's address and alarm condition. At least the first ten (10) devices on each circuit shall also have their alarm LEDs lighted.
 - b. Operate all control modules for the alarm or operated condition. Each module shall display it's address and condition.
 - c. Reset all alarmed and operated devices. The panel shall display the address or zone of any off-normal devices.
 - d. Test a representative number of sensors for alarm verification by momentarily testing for alarm. The sensor shall not initiate an alarm. Then, test by placing the sensor in alarm such that it remains in alarm for the selected verification time. The sensor shall initiate an alarm.
 - e. Acceptance of the system shall also require a demonstration of the stability of the system. This shall be adequately demonstrated if the system operates for a ninety (90) day test period without any unwarranted alarms. Should unwarranted alarm(s) occur, the Contractor

shall readjust or replace the detector(s) and begin another ninety (90) day test period. As required by the Architect-Engineer the Contractor shall recheck the detectors using the fire test after each readjustment or replacement of detectors. This test shall not start until the Owner has obtained beneficial use of the building under tests.

- f. If the requirements provided in the paragraph above are not completed within thirty (30) days after beginning the tests described therein, the Contractor shall replace the system with another acceptable manufacturer and the process repeated until acceptance of the equipment by the Owner.
 - g. Before final acceptance of work; the Contractor shall deliver seven (7) copies of a composite "Operating and Shop Maintenance Manual." Each manual shall contain, but not be limited to:
 - h. A statement of guarantee including date of termination and name and phone number of the person to be called in the event of equipment failure.
 - i. Individual factory issued manuals containing all technical information on each piece of equipment installed. In the event that such manuals are not obtainable from the factory, it shall be the responsibility of the Contractor to compile and include them. Advertising brochures or operational instructions shall not be used in lieu of the required technical manuals.
 - j. One (1) copy of all approved shop drawings, instruction sheets, operating instructions, and spare parts bulletins.
 - k. A training session, for personnel selected by the Owner, shall be presented by a fully qualified, trained representative of the equipment manufacturer who is thoroughly knowledgeable of the specific installation.
 - l. Provide a written description of standard control panel functions and user instructions at each FACP. These instructions shall be written in standard laymen's English so that an unfamiliar operator can accomplish basic functions such as reset.
- E. Warranty: All equipment and systems shall be warranted by the Contractor for a period of one (1) year following the date of final acceptance. The warranty shall include parts, labor, prompt field service, pick-up, and delivery.
- 1. At the end of the one year warranty, provide testing as per National Fire Protection Association 72, which shall consist of: Provide a Test and Written report which certify that all initiating devices have been tested and which indicate the result of the inspection. Provide the required certification tag. Problems discovered during this testing and inspection shall be covered under the warranty. It is the contractor's responsibility to perform this testing prior to the end of the one year warranty or provide an extended warranty if the test is performed after the warranty period was scheduled to expire.

END OF SECTION 28 31 11

SECTION 28 51 19.13
VIDEO WALLS

PART 1 - GENERAL

1.01 SUMMARY

- A. Provide an integrated audio-visual system to support the operation of a multi-monitor video wall system, consisting of a main video wall (60 monitors) and two adjacent video walls (12 vertical monitors each).
- B. The system shall be configured to display live feeds from up to 240 1080p cameras, PC sources, and encoded video streams.
- C. Scope includes hardware, software, training, commissioning, and warranty services.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00:
 - 1. Refer to "PART 2 – Products" for all Buy America Build America Act (BABA) Requirements

1.03 SUBMITTALS

- A. Product data sheets for all hardware and software components.
- B. Installation drawings and detailed system configuration.
- C. User guides and training materials.

1.04 WARRANTY

- A. Provide a 5-year warranty on all hardware and software, including service and support.
- B. Offer options for warranty extension as per manufacturer guidelines.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Jupiter Systems, Legrand Wiremold, Samsung, Pelco, or approved equivalents.

2.02 COMPONENTS

- A. CatalystXL for Main Video Wall
 - 1. Processor Configuration
 - a. 16-core Intel Xeon processor operating at 2.9 GHz.
 - b. 192 GB DRAM for seamless multi-stream processing.

- c. Windows 10 LTSC operating system optimized for performance.
 - 2. Output Capacity
 - a. 15 4K channels connected to J4 breakout boxes.
 - b. Each J4 breakout box supports 4x 1080p outputs, delivering full resolution across 60 monitors.
 - 3. Input Capacity
 - a. 4x HDMI inputs supporting HD/4K30 resolutions.
 - b. Up to 240 H.264 streams at HD30 resolution, scalable for future camera additions.
 - 4. Storage
 - a. Three 1 TB solid-state drives in RAID1 configuration, including a hot swap spare for redundancy.
 - 5. Chassis and Power
 - a. Rackmountable CPU and express chassis with redundant 700W and 2000W power supplies, respectively.
 - b. High-efficiency cooling with mid-chassis and rear-chassis fan assemblies.
 - 6. Critical Spares Kit
 - a. Includes spare fan assemblies, 64 GB memory kit, 1 TB SSD, 16-core Xeon processor, GPU boards, and a decoder card.
- B. CatalystXL for Adjacent Walls
 - 1. Processor Configuration
 - a. Two additional CatalystXL units, each dedicated to one adjacent wall.
 - b. 16-core Intel Xeon processors with 192 GB DRAM each.
 - 2. Output Capacity
 - a. Each CatalystXL outputs 12 display channels at 3840x2160 resolution (4x3 layout per wall).
 - b. Active adapters included for DisplayPort-to-HDMI conversions.
 - 3. Input Capacity
 - a. Each unit supports 4 HDMI inputs and 4 H.264 HD30 streams.

- C. J4 Components for Main Wall Distribution
 - 1. Breakout Functionality
 - a. 15 J4 HDMI video wall appliances connected to CatalystXL via 15 output channels.
 - b. Each J4 appliance splits 1 HDMI input into 4 HDMI outputs, providing seamless 1080p resolution across 60 monitors.
 - 2. Features
 - a. Supports up to 4K resolution at 60 Hz on the input.
 - b. RJ-45 Ethernet port for command and control.
 - 3. Configuration for Scalability
 - a. J4 units are rack-mounted using provided kits to ensure organized and efficient deployment.
- D. Canvas Software
 - 1. Licenses
 - a. 1x Canvas Server license with Active Directory integration.
 - b. 8x Floating licenses for operator use.
 - c. 4x Named licenses for managerial use.
 - 2. Functionality
 - a. Real-time collaboration and video sharing across all connected displays.
 - b. Supports future scaling with additional redundant servers if required.
- E. StreamPoint Encoder
 - 1. Input/Output Capacity
 - a. 4x HDMI inputs with corresponding loop-through outputs.
 - b. Supports encoding resolutions up to 4K30 per channel.
 - 2. Stream Management
 - a. Compatible with H.264 encoding and RTSP/RTP streaming protocols.
 - b. Flexible setup for single or multi-stream configurations.
- F. Backboxes

1. Basis of Design
 - a. Legrand Wiremold PAC525 and PAC526 Series Wall Boxes.
2. Dimensions
 - a. PAC525: 9" x 14.25" x 3.9" with adjustable depth.
 - b. PAC526: 14.25" x 14.25" x 3.9" with adjustable depth.
3. Features
 - a. UL 2416-rated steel enclosures with integrated zip tie anchor points for cable management.
 - b. Multiple knockout configurations for flexibility in AC outlets and conduits.
4. Installation
 - a. Secure backboxes to wood or steel studs or directly to drywall.
 - b. Coordinate with electrical contractors for proper conduit alignment.

G. Displays

1. Basis of Design
 - a. Model: Samsung QB55B-N
2. Specifications
 - a. Screen Size: 55 inches (diagonal).
 - b. Resolution: 3840 x 2160 (4K UHD).
 - c. Brightness: 350 nits.
 - d. Contrast Ratio: 4000:1.
 - e. Orientation: Landscape or Portrait.
 - f. Operating Hours: 16/7.
 - g. Bezel Width: 9.2 mm (top/left/right), 11.2 mm (bottom).
3. Mounting System
 - a. VESA Mount Compatibility: 200 x 200 mm.
 - b. Ensure seamless bezel transitions during installation. Monitors must be aligned so that no gap between adjacent monitors exceeds 1/8th of an inch.

4. Power and Connectivity
 - a. Voltage: 100–240 V AC, 50/60 Hz.
 - b. Power Consumption: Typical 96 W; Maximum 143 W.
 - c. Inputs: HDMI 2.0 (x3), USB 2.0 (x2), RS232C (in/out), RJ45.

H. Display Mounts

1. Basis of Design
 - a. Mount-It MI-363
2. Specifications
 - a. VESA patterns from 200x200mm to 600x400mm, up to 70" displays.
 - b. Mount dimensions: 670x524x95mm
 - c. Load capacity: 154 lbs
 - d. Push in, pop out design for installation and maintenance access.
 - e. Side slots to connect multiple mounts together.
3. Adjustment
 - a. 3 degrees of rotation.
 - b. Extension: 3.7" minimum to 11.2" maximum.
 - c. Horizontal and depth adjustments to create seamless video wall.
 - d. Multidimensional micro adjustment for precise alignment.

2.03 ACCESSORIES

- A. PTZ keyboard with full compatibility to video wall controller according to Jupiter Systems manufacturer recommendations.
- B. Rackmount kits for secure installation of CatalystXL and J4 components.
- C. Backup SSD drive for system snapshots and recovery.
- D. Trusted Platform Module (TPM) for enhanced security.

PART 3 - EXECUTION

3.01 ACCESSORY INSTALLATION

- A. Install and configure CatalystXL processors, J4 appliances, StreamPoint encoder, and all

accessories in the designated control room.

- B. Ensure proper cabling, power distribution, and network connectivity for all components.
- C. Set up and test the Canvas software to ensure full operational capability.

3.02 COMMISSIONING

- A. Conduct a thorough review of the system, including hardware performance, software integration, and display calibration.
- B. Validate functionality for all video walls, including main wall and adjacent walls, with connected cameras and PC sources.

3.03 TRAINING

- A. Provide a comprehensive one-day training session on system operation and maintenance, including CatalystXL and Canvas software.

3.04 MAINTENANCE AND SUPPORT

- A. Jupiter Care subscription for ongoing software updates and hardware support.
- B. Provide cleaning and preventive maintenance recommendations for displays and enclosures.
- C. Include guidelines for firmware updates to maintain compatibility.

END OF SECTION 28 51 19.13

SECTION 31 05 00
COMMON EARTHWORK REQUIREMENTS

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Furnish all labor, materials, equipment, tools and services required to fully complete all Common Earthwork Requirements as required by the Drawings and/or specified herein including, but not limited to, the following described items.
 - 1. General procedures and requirements for Earthwork.

1.02 RELATED REQUIREMENTS

- A. Section 01 11 00 – Summary of Work
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) Requirements

PART 2 - PRODUCTS: NOT USED

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Site Verification of Conditions:
 - 1. Perform minor, investigative excavations to verify location of various existing underground facilities at sufficient locations to assure that no conflict with the proposed work exists and sufficient clearance is available to avoid damage to existing facilities.
 - 2. Perform investigative excavating 10 days minimum in advance of performing any excavation or underground work.
 - 3. Upon discovery of conflicts or problems with existing facilities, notify Architect by phone or fax within 24 hours. Follow telephone or fax notification with letter and diagrams indicating conflict or problem and sufficient measurements and details to evaluate problem.

3.02 PREPARATION

- A. Protection:
 - 1. Spillage:
 - a. Avoid spillage by covering and securing loads when hauling on or adjacent to public street or highways.

- b. Remove spillage and sweep, wash, or otherwise clean project, streets, and highways.
 - 2. Dust Control:
 - a. Take precautions necessary to prevent dust nuisance, both on-site and adjacent to public and private properties.
 - b. Correct or repair damage caused by dust.
 - 3. Existing Plants and Features: Do not damage tops, trunks, and roots of existing trees and shrubs no site that are intended to remain. Do not use heavy equipment within branch spread. Interfering branches may be removed only with permission of Architect. Do not damage other plants and features that are to remain.
- B. If specified precautions are not taken or corrections and repairs not made promptly, Owner may take such steps as may be deemed necessary and deduct costs of such from monies due to Contractor. Such action or lack of action on Owner's part does not relieve Contractor from responsibility for proper protection of The Work.

3.03 REPAIR/RESTORATION

- A. Adjust existing covers, boxes, and vaults to grade.
- B. Replace broken or damaged covers, boxes and vaults.
- C. Independently confirm size, location, and number of covers, boxes, and vaults that require adjustment.

3.04 FIELD QUALITY CONTROL

- A. Notify Architect 48 hours before performing excavation or fill work.
- B. If weather, scheduling, or any other circumstance has interrupted work, notify Architect 24 hours minimum before intended resumption of grading or compacting.
- C. Owner reserves right to require additional testing to re-affirm suitability of completed work including compacted soils that have been exposed to adverse weather conditions.

END OF SECTION 31 05 00

SECTION 31 11 00
CLEARING AND GRUBBING

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Furnish all labor, materials, equipment, tools and services required to full complete all Clearing and Grubbing work as required by the Drawings and/or specified herein including, but not limited to, the following described items.
 - 1. Perform clearing and grubbing as necessary to prepare site for rough grading and structure excavation as described in Contract Documents.

1.02 RELATED REQUIREMENTS

- A. Section 01 11 00 – Summary of Work
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) Requirements
- B. Section 31 05 00 – Common Earthwork Requirements.

PART 2 - PRODUCTS: NOT USED

PART 3 - EXECUTION

3.01 PERFORMANCE

- A. Tree and Brush Removal:
 - 1. Cut off trees, shrubs, brush, and vegetative growth 12 inches maximum above ground.
 - 2. Do not pull up or rip out roots of trees and shrubs that are to remain. If excavation through roots is required, excavate by hand and cut roots with sharp axe. Make clean, smooth, sloping cuts.
 - 3. Cut roots 6-inches or larger in diameter only with Architect’s written permission.
- B. Grubbing:
 - 1. Grub out stumps and roots 12-inches minimum below original ground surface, except as follows:
 - a. Under buildings, remove roots one inch and larger entirely.
 - b. Entirely remove roots of plants that normally sprout from roots, as identified by Architect.

3.02 CLEANING

- A. Remove from site trees, shrubs, uprooted stumps, vegetative layer, and surface debris and dispose of legally.
- B. Do not bury cuttings, stumps, roots, and other vegetative matter or burnt waste material on site.

3.03 PROTECTION

- A. Provide protection necessary to prevent damage to existing improvements, trees or vegetation, light poles, power poles, fire hydrants, etc., indicated on the Contract Documents to remain.
- B. Protect improvements on adjoining properties and on Owner's property.
- C. Restore damaged improvements to original condition as acceptable to parties having jurisdiction.
- D. Conduct site clearing operations to ensure minimum interference with roads, streets, walks, and other adjacent occupied or used facilities. Do not close or obstruct streets, walks, and other adjacent occupied or used facilities without permission from authorities having jurisdiction. Streets and roadways shall be thoroughly cleaned and/or swept on a daily basis or more frequently as required by the governing authority.
- E. Provide traffic control as required, in accordance with the U.S. Department of Transportation "Manual of Uniform Traffic Control Devices" and the state highway department requirements.
- F. Unknown Utility Lines: All known utilities have been shown according to the information available. Contractor is responsible for coordinating with local utility companies and owner to locate and confirm all buried utilities in the construction area. Contractor is to notify architect immediately if unknown lines, pipes, or other underground objects are encountered.
- G. Mow and remove weeds and small undergrowth vegetation in the construction area as defined on the drawings.

END OF SECTION 31 11 00

SECTION 31 14 13
STRIPING AND STOCKPILING

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Furnish all labor, materials, equipment, tools and services required to full complete all Clearing and Grubbing work as required by the Drawings and/or specified herein including, but not limited to, the following described items.
 - 1. Strip and stockpile acceptable topsoil as described in Contract Documents.

1.02 RELATED REQUIREMENTS

- A. Section 01 11 00 – Summary of Work
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) Requirements
- B. Section 31 05 00 – Common Earthwork Requirements.
- C. Division 32 – Finish grading of existing topsoil stored on site and addition of imported topsoil.

1.03 DEFINITIONS

- A. Existing topsoil is defined as total amount of soil stripped and stored for reuse, less vegetation layer stripped and disposed of as specified in Paragraphs below.

PART 2 - PRODUCTS: NOT USED

PART 3 - EXECUTION

3.01 PERFORMANCE

- A. Strip existing vegetation layer 6-inches deep minimum, or as otherwise directed by the Geotechnical Report, from areas of site to receive buildings, landscaping, and paving and remove from site before stripping topsoil for storage and reuse.
- B. After stripping vegetation layer, strip existing topsoil an additional 6-inches deep minimum, or as otherwise directed by Geotechnical Report, from areas of site to receive buildings and paving and store on site for later use.
 - 1. Existing topsoil is property of Contractor with restriction that topsoil is to be used first for Project landscape topsoil requirements and second for non-structural fill and backfill.

2. After Project fill, backfill, and landscape topsoil requirements are satisfied, remove excess existing topsoil from site. Do not remove existing topsoil from site without Architect's written approval.

END OF SECTION 31 14 13

SECTION 31 20 00
EARTH MOVING

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Furnish all labor, materials, equipment, tools and services required to full complete all Earth Moving work as required by the Drawings and/or specified herein including, but not limited to the following described items.
- B. Preparing subgrades for slabs-on-grade, sidewalks, pavements, lawns and grasses, and exterior plants.
 - 1. Excavating and backfilling for buildings and structures.
 - 2. Drainage course for slabs-on-grade.
 - 3. Subbase course for concrete sidewalks and pavements.
 - 4. Subbase and base course for concrete paving.
 - 5. Subsurface drainage backfill for walls and trenches.
 - 6. Excavating and backfilling for utility trenches.
 - 7. Excavating and backfilling trenches for buried mechanical and electrical utilities and pits for buried utility structures.

1.02 RELATED REQUIREMENTS

- A. Section 01 11 00 – Summary of Work
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) Requirements
- B. Division 01 Section “Temporary Facilities and Controls” for temporary controls, utilities, and support facilities.
- C. Division 22 Sections for installing underground mechanical and electrical utilities and buried mechanical and electrical structures.
- D. Division 31 Section “Site Clearing” for temporary erosion and sedimentation control measures, site stripping, grubbing, stripping and stockpiling topsoil, and removal of above- and below-grade improvements and utilities.
- E. Division 32 Section “Plants” for planting bed establishment and tree and shrub pit excavation and planting.

1.03 DEFINITIONS

- A. Backfill: Soil material or controlled low-strength material used to fill an excavation.

1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
 2. Final Backfill: Backfill placed over initial backfill to fill a trench.
- B. Base Course: Course placed between the subbase course and paving.
- C. Bedding Course: Course placed over the excavated subgrade in a trench before laying pipe.
- D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.
- E. Drainage Course: Course supporting the slab-on-grade that also minimizes upward capillary flow of pore water.
- F. Excavation: removal of material encountered above subgrade elevations and to lines and dimensions indicated.
1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Architect. Authorized additional excavation and replacement material will be paid for according to Contract provisions for change in the Work.
 2. Bulk Excavation: Excavation more than 10 in width and more than 30 feet in length.
 3. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Architect. Unauthorized excavation, as well as remedial work directed by Architect, shall be without additional compensation.
- G. Fill: Soil materials used to raise existing grades.
- H. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.
- I. Subbase Course: Course placed between the subgrade and base course for hot-mix asphalt pavement, or course placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt sidewalk.
- J. Subgrade: Surface or elevation remaining after completing excavation, or top surface of a fill or backfill immediately below subbase, drainage fill, or topsoil materials.
- K. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

1.04 SUBMITTALS

- A. Product Data: For the following:
1. Each type of plastic warning tape.

- B. Material Test Reports: From a qualified testing agency indicating and interpreting test results for compliance of the following with requirements indicated:
 - 1. Classification according to ASTM D2487 of each on-site and borrow soil material proposed for fill and backfill.
 - 2. Laboratory compaction curve according to ASTM D1557 for each on-site and borrow soil material proposed for fill and backfill.
- C. Pre-Excavation Photographs: Show existing conditions of adjoining construction and site improvements, including finish surfaces, that might be misconstrued as damage caused by earthwork operations. Submit before earthwork begins.

1.05 QUALITY ASSURANCE

- A. Geotechnical Testing Agency Qualifications: An independent testing agency qualified according to ASTM E 329 to conduct soil materials and rock-definition testing, as documented according to ASTM D3740 and ASTM E548.
- B. Pre-Excavation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination".

1.06 PROJECT CONDITIONS

- A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by Architect and then only after arranging to provide temporary utility services according to requirements indicated.
 - 1. Notify Owner not less than two days in advance of proposed utility interruptions.
 - 2. Do not proceed with utility interruptions without Architect's written permission.
 - a. Contact utility-locator service for area where Project is located before excavating.
- B. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies to shut off services if lines are active.

PART 2 - PRODUCTS

2.01 SOIL MATERIALS

- A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.
- B. Satisfactory Soils: Soil meeting the material requirements of Section 31 23 23.
- C. Unsatisfactory Soils: Soil not meeting satisfactory soil criteria given above and soil containing debris, waste, frozen material, vegetation and other deleterious matter.
 - 1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.

- D. Subbase Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2 inch sieve and not more than 12 percent passing a No. 200 sieve.
- E. Base Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940; with at least 95 percent passing a 1-1/2 inch sieve and not more than 8 percent passing a No. 200 sieve.
- F. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940; with at least 90 percent passing a 1-1/2 inch sieve and not more than 12 percent passing a No. 200 sieve.
- G. Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940; except with 100 percent passing a 1 inch sieve and not more than 8 percent passing a No. 200 sieve.
- H. Drainage Course: Narrowly graded mixture of washed crushed stone, or crushed or uncrushed gravel; ASTM D448; coarse-aggregate grading size 57; with 100 percent passing a 1-1/2 inch sieve and 0 to 5 percent passing a No. 8 sieve.
- I. Filter Material: Narrowly graded mixture of natural or crushed gravel, or crushed stone and natural sand; ASTM D4488; coarse-aggregate grading Size 67; with 100 percent passing a 1 inch sieve and 0 to 5 percent passing a No. 4 sieve.
- J. Sand: ASTM C 33; fine aggregate, natural, or manufactured sand.
- K. Impervious Fill: Clayey sand mixture capable of compacting to a dense state.

2.02 ACCESSORIES

- A. Detectable Warning Tape: Acid- and alkali-resistant polyethylene 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 the 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 as follows:
 1. Red: Electric.
 2. Yellow: Gas, oil, steam, and dangerous materials.
 3. Orange: Telephone and other communications.
 4. Blue: Water systems.
 5. Green: Sewer systems.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by

earthwork operations.

- B. Preparation of subgrade for earthwork operations including removal of vegetation, topsoil, debris, obstructions, and deleterious materials from ground surface is specified in Division 31 Section "Site Clearing".
- C. Protect and maintain erosion and sedimentation controls, which are specified in Section 31 35 00 Slope Protection and Erosion Control during earthwork operations.
- D. Provide protective insulating materials to protect subgrades and foundation soils against freezing temperatures or frost.

3.02 DEWATERING

- A. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.
- B. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.
 - 1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.
 - 2. Install a dewatering system to keep subgrades dry and convey ground water away from excavations. Maintain until dewatering is no longer required.

3.03 EXPLOSIVES

- A. Explosives: Do not use explosives.

3.04 EXCAVATION, GENERAL

- A. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation or removal of obstructions.
 - 1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.
 - 2. Remove rock to lines and grades indicated to permit installing of permanent construction without exceeding the following dimensions:
 - a. 24 inches outside of concrete forms other than at footings.
 - b. 12 inches outside of concrete forms at footings.
 - c. 6 inches outside of minimum required dimensions of concrete cast against grade.
 - d. Outside dimensions of concrete walls indicated to be cast against rock

without forms or exterior waterproofing treatments.

- e. 6 inches beneath bottom of concrete slabs on grade.
- f. 6 inches beneath pipe in trenches, and the greater of 24 inches wider than pipe or 42 inches wide.

3.05 EXCAVATION FOR STRUCTURES

- A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.
 - 1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grade to leave solid base to receive other work.
 - 2. Excavation for Underground Tanks, Basins, and Mechanical or Electrical Utility Structures: Excavate to elevations and dimensions indicated within a tolerance of plus or minus 1 inch. Do not disturb bottom of excavations intended as bearing surfaces.

3.06 EXCAVATION FOR SIDEWALKS AND PAVEMENTS

- A. Excavate surfaces under sidewalks and pavements to indicated lines, cross sections, elevations, and subgrades.

3.07 EXCAVATION FOR UTILITY TRENCHES

- A. Excavate trenches to indicated gradients, lines, depths, and elevations.
 - 1. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line.
- B. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench wall vertically from trench bottom to 12 inches higher than top of pipe or conduit, unless otherwise indicated.
 - 1. Clearance: 12 inches each side of pipe or conduit.
- C. Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells, joint, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove projecting stones and sharp objects along trench subgrade.
 - 1. For pipes and conduit less than 6 inches in nominal diameter and flat-bottomed, multiple duct conduit units, hand-excavate trench bottoms and support pipe and conduit on an undisturbed subgrade.
 - 2. For pipes and conduit 6 inches or larger in nominal diameter, shape bottom of trench to support bottom 90 degrees of pipe circumference. Fill depressions with tamped

sand backfill.

3. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

3.08 SUBGRADE INSPECTION

- A. Notify Architect when excavations have reached required subgrade.
- B. If Architect determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.
- C. Proof-roll subgrade below the building slabs and pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.
 1. Completely proof-roll subgrade in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph.
 2. Proof-roll with a loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons.
 3. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Architect, and replace with compacted backfill or fill as directed.
- D. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.
- E. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Architect, without additional compensation.

3.09 UNAUTHORIZED EXCAVATION

- A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation or concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of 2500 psi, may be used when approved by Architect.
 1. Fill unauthorized excavations under other construction or utility pipe as directed by Architect.

3.10 STORAGE OF SOIL MATERIALS

- A. Stockpile bottom soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
 1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.11 BACKFILL

- A. Place and compact backfill in excavation promptly, but not before completing the following:
 - 1. Construction below finish grade including, where applicable, subdrainage, damp proofing, waterproofing, and perimeter insulation.
 - 2. Surveying locations of underground utilities for Record Documents.
 - 3. Testing and inspecting underground utilities.
 - 4. Removing concrete formwork.
 - 5. Removing trash and debris.
 - 6. Removing temporary shoring and bracing, and sheeting.
 - 7. Installing permanent or temporary horizontal bracing on horizontally supported walls.
- B. Place backfill on subgrades free of mud, frost, snow, or ice.

3.12 UTILITY TRENCH BACKFILL

- A. Place backfill on subgrades free of mud, frost, snow, or ice.
- B. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.
- C. Backfill trenches excavated under footings and within 18 inches of bottom of footings with satisfactory soil; fill with concrete to elevation of bottom of footings. Concrete is specified in Division 03 Section "Cast-in-Place Concrete".
- D. Provide 4-inch thick, concrete base slab support for piping or conduit less than 30 inches below surface of roadways. After installing and testing, completely encase piping or conduit in a minimum of 4 inches of concrete before backfilling or placing roadway subbase.
- E. Place and compact initial backfill of subbase material, free of particles larger than 1 inch in any dimension, to a height of 12 inches over the utility pipe or conduit.
 - 1. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of utility piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.
- F. Backfill voids with satisfactory soil while installing and removing shoring and bracing.
- G. Place and compact final backfill of satisfactory soil to final subgrade elevation.
- H. Install warning tape directly above utilities, 12 inches below finished grade, except 6 inches

below subgrade under pavements and slabs.

3.13 SOIL FILL

- A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.
- B. Place and compact fill material in layers to required elevations as follows:
 - 1. Under grass and planted areas, use satisfactory soil material.
 - 2. Under sidewalks and pavements, use stable subgrade or compacted select fill compacted to 98% standard proctor density.
 - 3. Under steps and ramps, use engineered fill.
 - 4. Under building slabs, use engineered fill.
 - 5. Under footings and foundations, use engineered fill.
- C. Place soil fill on subgrades free of mud, frost, snow, or ice.

3.14 SOIL MOISTURE CONTROL

- A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.
 - 1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
 - 2. Remove and replace, or scarify and air dry otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.15 COMPACTION OF SOIL BACKFILLS AND FILLS

- A. Place backfill and fill soil materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.
- B. Place backfill and fill soil materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.
- C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D 1557:
 - 1. Under structures, building slabs, steps, and pavements, scarify and recompact top 12 inches of existing subgrade and each layer of backfill or fill soil material at 95 percent.
 - 2. Under walkways, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 95 percent.

3. Under lawn or unpaved areas, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 90 percent.
4. For utility trenches, compact each layer of initial and final backfill soil material at 95 percent.

3.16 GRADING

- A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.
 1. Provide a smooth transition between adjacent existing grades and new grades.
 2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.
- B. Site Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:
 1. Lawn or Unpaved Areas: Plus or minus 1 inch.
 2. Sidewalks: Plus or minus 1 inch.
 3. Pavements: Plus or minus 1/2 inch.
- C. Grading inside Building Lines: Finish subgrade to a tolerance of 1/2 inch when tested with a 10-foot straightedge.

3.17 SUBSURFACE DRAINAGE

- A. Subdrainage Pipe: Specified in Division 33 Section "Subdrainage".
- B. Subsurface Drain: Place subsurface drainage geotextile around perimeter of subdrainage trench. Place a 6 inch course of filter material on subsurface drainage geotextile to support subdrainage pipe. Encase subdrainage pipe in a minimum of 12 inches of filter material, placed in compacted layers 6 inches thick, and wrap in subsurface drainage geotextile, overlapping sides and ends at least 6 inches. Subsurface geotextile shall be Mirafi 1040N or equivalent.
 1. Compact each filter material layer to 90 percent of maximum dry unit weight according to ASTM D 1557 with a minimum of two passes of a plate-type vibratory compactor.
- C. Drainage Backfill: Place and compact filter material over subsurface drain, in width indicated, to within 12 inches of final subgrade, in compacted layers 6 inches thick. Overlay drainage backfill with 1 layer of subsurface drainage geotextile, overlapping sides and ends at least 6 inches.
 1. Compact each filter material layer to 90 percent of maximum dry unit weight according to ASTM D 1557 with a minimum of two passes of a plate-type vibratory compactor.

2. Place and compact impervious fill over drainage backfill in 6 inch thick compacted layers to final subgrade.

3.18 SUBBASE AND BASE COURSES

- A. Place subbase and base course on subgrades free of mud, frost, snow, or ice.
- B. On prepared subgrade, place subbase and base course under pavements and sidewalks as follows:
 1. Place base course material over subbase course under pavement,
 2. Shape subbase and base course to required crown elevations and cross-slope grades.
 3. Place subbase and base course 6 inches or less in compacted thickness in a single layer.
 4. Place subbase and base course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.
 5. Compact subbase and base course moisture conditioned to plus or minus 2 percent of optimum moisture content, to required grades, lines, cross sections, and thickness to not less than 98 percent of maximum dry unit weight according to ASTM D 698.
- C. Pavement Shoulders: Place shoulders along edges of subbase and base course to prevent lateral movement. Construct shoulders, at least 12 inches wide, of satisfactory soil materials and compact simultaneously with each subbase and base layer to not less than 98 percent of maximum dry unit weight according to ASTM D 698.

3.19 DRAINAGE COURSE

- A. Place drainage course on subgrades free of mud, frost, snow, or ice.
- B. On prepared subgrade, place and compact drainage course under cast-in-place concrete slabs on-grade as follows:
 1. Place drainage course 6 inches or less in compacted thickness in a single layer.
 2. Place drainage course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.
 3. Compact each layer of drainage course to required cross sections and thicknesses to not less than 95 percent of maximum dry unit weight according to ASTM D 1557.

3.20 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified independent geotechnical engineering

testing agency to perform field quality control testing.

- B. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earthwork only after test results for previously completed work comply with requirements.
- C. Footing Subgrade: Foundation excavations should be observed by a representative of the geotechnical engineer prior to fill or concrete placement. Subsequent verifications and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by Architect.
- D. Testing agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2922, and ASTM D 2937, as applicable. Tests will be performed at the following locations and frequencies:
 - 1. Paved and Building Slab Areas: At subgrade and at each compacted fill and backfill layer, at least 1 test for every 2000 sq. ft. or less of paved area or building slab, but in no case fewer than 3 tests.
 - 2. Foundation Wall Backfill: At each compacted backfill layer, at least 1 test for each 100 feet or less of wall length, but no fewer than 2 tests.
 - 3. Trench Backfill: At each compacted initial and final backfill layer, at 1 test for each 150 feet or less of trench length, but no fewer than 2 tests.
- E. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil to depth require; recompact and retest until specified compaction is obtained.

3.21 PROTECTION

- A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.
- B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they loose compaction due to subsequent construction operations or weather conditions.
 - 1. Scarify or remove and replace soil material to depth as directed by Architect; reshape and recompact.
 - 2. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.
 - a. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.22 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Disposal: Remove surplus satisfactory soil and waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off Owner's property.

END OF SECTION 31 20 00

SECTION 31 22 13
ROUGH GRADING - SITE

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Furnish all labor, materials, equipment, tools and services required to fully complete all Rough Grading work as required by the Drawings and/or specified herein including, but not limited to the following described items.
 - 1. Perform rough grading work required to prepare site for construction as described in Contract Documents.

1.02 RELATED REQUIREMENTS

- A. Section 01 11 00 – Summary of Work
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) Requirements
- B. Section 31 05 00 – Common Earthwork Requirements

1.03 QUALITY ASSURANCE

- A. Pre-Installation Conference:
 - 1. Schedule conference after completion of site clearing but before beginning grading work.
 - 2. Identify benchmark to be used in establishing grades and review Contract Document requirements for grades, fill materials, and topsoil.
 - 3. Examine site to pre-plan procedures for making cuts, placing fills, and other necessary work.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Materials used for fill shall be as specified for backfill in Section 31 23 23.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Before making cuts, remove topsoil over areas to be cut and filled that was not previously removed by stripping specified in Section 31 14 13. Stockpile this additional topsoil with previously stripped topsoil.

3.02 PERFORMANCE

A. Site Tolerances:

1. Maximum variation from required grades shall be 6 inches.

B. Compact fills as specified in Section 31 23 23.

C. If soft spots, water, or other unusual and unforeseen conditions affecting grading requirements are encountered, stop work and notify Architect.

END OF SECTION 31 22 13

SECTION 31 23 16
EXCAVATION

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Furnish all labor, materials, equipment, tools and services required to fully complete all Excavation work as required by the Drawings and/or specified herein including, but not limited to, the following described items.
 - 1. Perform Project excavating and trenching as described in Contract Documents, except as specified below.
 - 2. Procedure and quality for excavating and trenching performed on project under other Sections unless specifically specified otherwise.

1.02 RELATED REQUIREMENTS

- A. Section 01 11 00 – Summary of Work
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) Requirements
- B. Section 31 05 00 – Common Earthwork Requirements.
- C. Section 31 11 00 – Clearing and Grubbing.
- D. Section 31 23 23 – Fill.
- E. Performance of excavating inside and outside of building required for electrical and mechanical work is responsibility of respective Section doing work unless arranged differently by Contractor.

1.03 QUALITY ASSURANCE

- A. Pre-Installation Conference: Participate in pre-installation conference specified in Section 31 22 13.

PART 2 - PRODUCTS: NOT USED

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Carefully examine site and available information to determine type soil to be encountered. Discuss problems with Architect before proceeding with work.

3.02 PREPARATION

A. Protection of Existing Utilities:

1. Protect existing utilities identified in Contract Documents during excavation.
2. If existing utility lines not identified in Contract Documents are encountered, contact Architect before proceeding.

3.03 PERFORMANCE

A. Excavation:

1. Building Footings and Foundations:

- a. Excavate as necessary for proper placement and forming of footings and foundations.
- b. Bottom of excavations to receive footings shall be undisturbed soil.
- c. Excavation Carried Deeper Than Required:
 - (1) Under Footings: Fill with concrete specified for footings.
 - (2) Under Slabs: Use specified compacted backfill material.

2. Pavement and Miscellaneous Cast-In-Place Concrete:

- a. Excavate as necessary for proper placement and forming of concrete site elements and pavement structure. Remove vegetation and deleterious material and remove from site.
- b. Backfill over-excavated areas with compacted base material specified in Section 31 23 23.
- c. Remove and replace exposed material that becomes soft or unstable.

3. Utility Trenches:

- a. Unless otherwise indicated, excavation shall be open cut. Short sections of trench may be tunneled if pipe or duct can be safely and properly installed and backfill can be properly tamped in tunnel sections and if approved by Architect.
- b. Excavate to proper alignment, depth, and grade. Excavate to sufficient width to allow adequate space for proper installation and inspection of utility piping.
- c. If trenches or excavate deeper than required, backfill until trench bottom is proper depth with properly compacted native material.
- d. Pipe 4 Inch in Diameter or Larger:

- (1) Grade bottom of trenches to provide uniform bearing and support for each section of pipe on undisturbed soil at every point along its length.
- (2) Except where rock is encountered, take care not to excavate below depths indicated.
 - Where rock excavations are required, excavate rock with minimum over-depth of 4 inches below required trench depths.
 - Backfill over-depths in rock excavation and unauthorized over-depths with loose, granular, moist earth thoroughly compacted.
- (3) Whenever wet or unstable soil incapable of properly supporting pipe, as determined by Architect, occurs in bottom of trench, remove soil to depth required and backfill trench to proper grade with coarse sand, fine gravel, or other suitable material acceptable to Architect.

4. If unusual excavating conditions are encountered, stop work and notify Architect.

3.04 REPAIR/RESTORATION

- A. Repair damage to other portions of the Work resulting from work of this Section at no additional cost to Owner. On new work, arrange for damage to be repaired by original installer.

3.05 CLEANING

- A. Debris and material not necessary for Project are property of Contractor and are to be removed before completion of Project. However, if material necessary for Project is hauled away, replace with specified fill/backfill material.

END OF SECTION 31 23 16

SECTION 31 23 23
FILL

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Furnish all labor, materials, equipment, tools and services required to fully complete all Fill work as required by the Drawings and/or specified herein including, but not limited to, the following described items.
 - 1. Perform Project backfilling and compacting as described in Contract Documents, except as specified below.
 - 2. Procedure and quality for backfilling and compacting performed on Project under other Sections unless specifically specified otherwise.

1.02 RELATED REQUIREMENTS

- A. Section 01 11 00 – Summary of Work
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) Requirements
- B. Section 31 05 00 – Common Earthwork Requirements
- C. Division 32 – Compaction of sub-grade under sidewalks and paving.
- D. Performance of backfilling and compacting inside and outside of building required for electrical and mechanical work is responsibility of respective Section doing work unless arranged differently by Contractor.

1.03 DEFINITIONS

- A. Relative Compaction: Ratio of field dry density as determined by ASTM D 2922 and ASTM D 3017 or 2216, and laboratory maximum dry density as determined by ASTM D 1557 or ASTM D698.

1.04 QUALITY ASSURANCE

- A. Pre-Installation Conference: Participate in pre-installation conference specified in Section 31 22 13.

1.05 SEQUENCING

- A. Do not backfill against bituminous damp proofing for 24 hours after application of damp proofing.
- B. Before backfilling, show utility and service lines being covered on record set of Drawings. Do not backfill until utilities involved have been tested and approved by Architect until instructed by Architect.

PART 2 - PRODUCTS

2.01 ALL TO BE APPROVED BY ARCHITECT

2.02 MATERIALS

A. Imported Fill/Backfill:

1. Well graded material conforming to ASTM D 2487 free from debris, organic material, frozen materials, brick, lime, concrete, and other material which would prevent adequate performance of backfill.
 - a. Under Site Concrete and Paved Areas: Fill shall consist of non expansive granular soil with no more than 35% passing the number 200 sieve and a liquid limit of less than 55, or as otherwise directed by the Geotechnical Report or as approved by Soils Engineer during construction.
 - b. Under Landscaped Areas:
 - (1) Fill more than 36 inches below finish grade shall comply with soil classification groups GW, GP, GM, SW, SP, or SM. Fill may not contain stones over 6 inches diameter and 90 percent minimum of fill shall be smaller than 1.5 inches in any direction.
 - (2) Fill less than 36 inches below finish grade shall comply with soil classification groups SW, SP, SM, or SC. Fill may not contain stones larger than 1.5 inches in any direction and 90 percent minimum of fill shall be smaller than 0.25 inches in any direction.

B. Engineered Fill:

1. To be approved by Architect.

PART 3 - EXECUTION

3.01 PREPARATION

A. Before placing fill, base, or finish work, prepare sub-grade as follows:

1. Do not place fill or base over frozen sub-grade.
2. Under Building Slab/Pads, Concrete Site Elements, and Concrete Driveways and Parking Areas: Scarify sub-grade 6 inches deep, moisture condition to uniform moisture content and plus or minus 2% of optimum, and mechanically 6 inches deep to 98 percent minimum compaction in accordance with ASTM D 698.
3. Under Concrete Driveways and Parking Areas: Scarify subgrade 6 inches deep, moisture condition to uniform moisture content between optimum and plus or minus 2% of optimum, and mechanically tamp to 98 percent minimum compaction in accordance with ASTM D 698.
4. Landscape Areas: Compact subgrade to 90 percent compaction.

3.02 PERFORMANCE

A. Fill/Backfill:

1. General:

- a. Around Buildings and Structures: Slope grade away from building as specified in Section 31 22 16. Hand backfill when close to building or where damage to building might result.
- b. Site Utilities:
 - (1) In Landscape Areas: Use backfill consisting of on-site soil.
 - (2) Under Pavement and Concrete Site Elements: Extend excavatable slurry fill/backfill to elevation of subgrade. Do not place base material until excavatable slurry fill/backfill has cured 72 hours.
- c. Do not use puddling or jetting to consolidate fill areas.

2. Compacting:

a. Fill/Backfill and Base:

- (1) Under Building Slabs or Pads, Driveways, Parking Areas Under Concrete Site Elements and Around Foundation Walls: Place in 8 inch maximum layers, moisture condition to plus or minus 2 percent of optimum moisture content, and mechanically tamp to 95 percent minimum relative compaction.
- (2) Utility Trenches:
 - Site: Place fill in 8 inch layers and moisture condition to plus or minus 2 percent of optimum moisture content. Compact fill to 95 percent minimum relative compaction.
 - Under Concrete: Place fill in 6 inch layers as required, moisture condition to plus or minus 3 percent of optimum moisture content, and compact to 98 percent minimum compaction in accordance with ASTM D 698.
- (3) Fill Slopes: Compact by rolling or using sheepfoot roller.
- (4) Backfill Under Footings: Not allowed, unless specified on drawings.
- (5) Other Backfills: Place other fills in 12 inch layers and compact to 90 percent relative compaction.

3.03 REPAIR/RESTORATION

A. Repair damage to other portions of the Work resulting from work of this Section at no

additional cost to Owner. On new work, arrange for damage to be repaired by original installer.

3.04 CLEANING

- A. Debris and material not necessary for Project are property of Contractor and are to be removed before completion of Project. However, if material necessary for Project is hauled away, replace with specified fill/backfill material.

END OF SECTION 31 23 23

SECTION 31 25 00
EROSION AND SEDIMENTATION CONTROLS

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Installation of temporary and permanent erosion control systems.
- B. Installation of temporary and permanent slope protection systems.
- C. Contractor Responsibilities.

1.02 RELATED SECTIONS

- A. Section 01 11 00 – Summary of Work
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) Requirements
- B. Section 31 11 00 – Clearing and Grubbing.
- C. Section 31 05 00 – Common Earthwork Requirements.

1.03 ENVIRONMENTAL REQUIREMENTS

- A. Protect adjacent properties and water resources from erosion and sediment damage throughout life of contract.

1.04 CONTRACTOR RESPONSIBILITIES

- A. The Owner (through the Civil Engineer) will obtain all permits prior to beginning construction. The Contractor will be responsible for implementing and maintaining all requirements under the permit. This includes, but is not limited to, installing best management practices (BMP), maintaining/replacing of BMP's when needed, stabilizing all disturbed areas on the project, completing inspection report forms at the frequency specified in the permit, and maintaining the SWPPP, all required postings, and rain gauge on the site. If the Entity having jurisdiction issues a citation or fine over storm water quality, because of negligence by the Contractor in maintenance of the SWPPP, the Contractor will be responsible for payment of the fines or citation fees. The amount of the fines shall be withheld out of the amount due to the Contractor. The BMP's shown in the erosion control plans are minimum measures and additional or different BMPs may be necessary in the field. The contractor shall add or modify BMPs as necessary and document these changes in the SWPPP as required.
- B. A copy of the permit and SWPPP will be furnished to the Contractor at the Pre-construction meeting.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Quick growing grasses such as wheat, rye, or oats in accordance with Section 32 “Seeding” requirements.
- B. Stone check dams as specified on Construction Drawings.
- C. Fencing for siltation control as specified on Construction Drawings.
- D. Acceptable Filter/Drainage Fabrics:
 - 1. Mirafi 140 N
 - 2. Dupont Typar HR
 - 3. Approved Alternative
- E. Curlex Blankets by American Excelsior Company or approved alternative.
- F. Temporary mulches such as loose hay, straw, netting, wood cellulose, or agricultural silage.
- G. Fence stakes shall be minimum of 5-ft in length and be either metal stakes or 2-in x 2-in hardwood stakes driven 1’-6” into the ground.
- H. Riprap in accordance with Section 31 37 16.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Review Construction Drawings and Storm Water Pollution Prevention Plan.
- B. Deficiencies or changes on Construction Drawings or Storm Water Pollution Prevention Plan as it is applied to current conditions will be brought to the attention of the Owner or his designated representative for remedial action.

3.02 EROSION CONTROL AND SLOPE PROTECTION IMPLEMENTATION

- A. Place erosion control systems in accordance with Construction Drawings and Storm Water Pollution Prevention Plan.
- B. The Owner or his designated representative has authority to limit surface area of erodible earth material exposed by clearing and grubbing, excavation, borrow, and embankment operations and to direct Contractor to provide immediate permanent or temporary pollution control measures. Contractor will be required to incorporate permanent erosion control features into project at earliest practical time to minimize need for temporary controls. Cut slopes shall be permanently seeded and mulched when finish grades are achieved as excavation proceeds to extent considered desirable and practical.
- C. Temporary erosion control systems installed by Contractor shall be constantly maintained to control siltation during life of contract. Contractor must respond to maintenance or additional work as required by the Owner or his designated representative within 48 hours.

- D. Additional material and work required and authorized by the Owner or his designated representative which is beyond extent of Construction Drawings and Storm Water Pollution Prevention Plan shall be paid for by Owner.

Contractor is totally responsible to protect all slopes when erosion begins by whatever methods necessary.

END OF SECTION 31 25 00

SECTION 31 37 16
RIP RAP

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Material specifications for rip-rap used on project.
- B. Placement of rip-rap and related accessories.

1.02 RELATED SECTIONS

- A. Section 01 11 00 – Summary of Work
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) Requirements
- B. Section 31 23 00 – Excavation and Backfill
- C. Section 33 41 16 – Site Storm Utility Drainage Piping
- D. Erosion Control Plan

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Stone for rip-rap shall consist of field stone or rough unhewn quarry stone as nearly uniform in section as is practical. Stones shall be dense, resistant to action of air and water, and suitable for purpose intended.
- B. Filter Fabric: The filter fabric shall be a woven or unwoven synthetic fiber geotextile conforming to the requirements of ASSHTO M 288. Filter fabric shall be similar to Mirafi 140 N or Dupont Tyvar Style 3601, or approved alternate.

2.02 EQUIPMENT

- A. Off-site materials shall be transported to project using well maintained and operating vehicles. Once on site, transporting vehicles shall stay on designated haul roads and shall at no time endanger improvements by rutting, overloading, or pumping.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Identify required lines, levels, contours, and datum.
- B. Locate and identify existing utilities that are to remain and protect from damage.
- C. Notify utility companies to remove or relocate utilities that are in conflict with proposed improvements.

- D. Protect plant life, lawns, fences, existing structures, sidewalks, paving, and curbs from excavating equipment and vehicular traffic.
- E. Protect benchmarks, property corners, and other survey monuments from damage or displacement. If marker needs to be removed it shall be referenced by a licensed land surveyor and replaced, as necessary, by same.
- F. Prior to placing fill in low areas, such as previously existing creeks, ponds, or lakes, perform the following procedures:
 - 1. Dain water out by gravity with ditch having flow line lower than lowest elevation in low area. If drainage cannot be performed by gravity ditch, use adequate pump to obtain same results.
 - 2. After drainage of low area is complete, remove mulch, mud, debris, and other unsuitable material by using acceptable equipment and methods that will keep natural soils underlying low area dry and undisturbed.

3.02 PLACEMENT

- A. Filter fabric shall be placed directly on the prepared surface. Fabric sections may be placed vertically or horizontally on the slope. Adjacent fabric sections shall be joined by overlapping a minimum of 2” at the edges and pinning the overlapped strip with U-shaped wire pins or similar fasteners. Fasteners shall be inserted through both strips of overlapped fabric at increments approximately 4’ along the overlap. Additional pins shall be installed as necessary to prevent displacement of the fabric. Fabric shall be overlapped in the direction of water flow. The fabric shall be turned down and buried approximately 12” at the exterior limits. No construction equipment will be permitted directly on the fabric.
- B. Place rip-rap in areas where indicated on Construction Drawings.
- C. Slopes and other areas to be protected shall be dressed to line and grade shown on Construction Drawings prior to placing of rip-rap. Undercut areas to receive rip-rap to elevation equal to final elevation less average diameter of stones before placing rip-rap.
- D. Filter fabric and bedding stone shall be installed prior to placement of stones if so indicated on Construction Drawings. Bedding stone shall be quarried and crushed angular limestone in accordance with Section 32 11 16 and shall be 6-inches in depth. Filter fabric shall be as specified and detailed on Construction Drawings.
- E. Stones shall be placed so that greater portion of weight is carried by earth and not by adjacent stones. Stones shall be placed in single layer with close joints. Upright areas of stone shall make angle of approximately 90 degree with embankment slope. Courses shall be placed from bottom of embankment upward, with larger stones being placed in lower courses. Open joints shall be filled with spalls. Stones shall be embedded in embankment as necessary to present uniform top surface such that variation between tops of adjacent stones shall not exceed 3 inches.
- F. Where called for on construction drawings or required by city or county, riprap shall be grouted in place with grout conforming to the governing requirements.

END OF SECTION 31 37 16

SECTION 32 01 90
GENERAL PLANTING REQUIREMENTS

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Furnish all labor, materials, equipment, tools and services required to fully complete all Landscape Maintenance work as is indicated on the drawings and/or specified herein including, but not limited to, the following described items.
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) Requirements.
 - 2. Common procedures and requirements for one year landscape maintenance period.
 - 3. Repairs, adjustments, replacements and other actions related to a healthy and properly operating site, covered by the plans and specifications, are covered under warranty. They are to be inspected regularly and repaired/replaced as soon as possible.

1.02 RELATED REQUIREMENTS

- A. Section 32 8423: Underground Sprinklers
- B. Section 32 9001: General Planting Requirements
- C. Section 32 9223: Sodding
- D. Section 32 9300: Plants

1.03 SUBMITTALS

- A. Service Calendar: Completed service calendar per provided format.
- B. Site Inspection Report: Document provided to owner as specified to include, but not limited to:
 - 1. Meeting notes and action items.
 - 2. Documentation of the Soil Analysis Reports.
 - 3. The use of all chemicals for maintenance applications.
 - 4. A list of maintenance services performed at each maintenance visit.
 - 5. Documentation of evidence of pest issues, disease and nutrient deficiency.

1.04 QUALITY ASSURANCE

- A. Landscape Maintenance Contractor:

1. Company with a minimum of five years of experience with work of this type, scale and complexity, whose work has resulted in successful establishment of exterior plants.
 - a. Employ Project Manager who meets the following criteria:
 - (1) Hold five years' experience of work of this type, scale and complexity.
 - b. Employ Supervisor who meets the following criteria:
 - (1) Hold two years' experience of work of this type, scale and complexity.
 - (2) Be fully trained and familiar with the maintenance of the types of plant material and irrigation system associated with this project.
 - (3) Be present on the project site at a minimum of 90% of the time the maintenance crew is present on site.
- B. Contractor Supervision: Contractor to ensure provision of qualified supervisor be present on- site during all landscape maintenance efforts to ensure high-quality work and to provide accurate, written reports to both Owner and Landscape Architect.
- C. Owner Education: Contractor to provide two educational and instructional sessions with Owner in order to provide review and instruction of maintenance zones, procedures and desired results. First session to be held prior to any work being started to provide Owner with an overview of the Contractor's intentions and allow for dialogue with Owner about Owners' desires for landscape appearance and function. Second session to be held at end of contract terms, one month prior to contract expiration.
- D. Owner's Rights: Owner reserves the right to organize, call and conduct meetings for purposes of discussing issues, needs and contractor performance. Owner to provide a minimum of 24 hours' notice prior to meeting. It is the responsibility of the Contractor to provide written documentation of meeting minutes to the Owner following each meeting.
- E. Protection of Property and Existing Structures: Contractor to employ proper practices and procedures to protect all property not being maintained and to avoid all damages to existing structures. Any damage incurred by non-inclusive property and caused to existing structures by Contractor action will be paid for and corrected by the Contractor at no additional cost to the Owner.
- F. The Work described in this Section as well as Landscape Grading, Plants, Seeding, Planting Irrigation, Snow Removal, and Horticultural and Irrigation Maintenance to be contracted to a single landscape contractor.

1.05 REGULATORY REQUIREMENTS

- A. Comply with regulatory agencies for fertilizer, herbicide and pesticide composition and application. The use of all chemicals for maintenance applications are to be reported to the Landscape Architect and Owner prior to application and subsequently be applied by a

trained and licensed Contractor/Operator.

1.06 ENVIRONMENTAL REQUIREMENTS

- A. Landscape maintenance processes of any type must comply with and conform to all state and federal requirements related to environmental practices and impacts with practices, equipment, substances and chemical applications and disposal.

1.07 COORDINATION

- A. Coordinate the work of this Section with final installation of and locations of all plant material beds and Landscape installations.
- B. Proceed with Work as rapidly as portions of Project site become available while working within seasonal limitations.

1.08 MAINTENANCE SERVICE

- A. Initial Maintenance Service, General: Beginning at Substantial Completion, provide one years' full maintenance service by skilled employees of Landscape Maintenance Contractor. Include maintenance, in a manner as indicated in Section 3.1 Quality Standard for all trees, shrubs, perennials, groundcovers, bulbs, irrigation and all other Landscape material installations.
 - 1. Perform maintenance during normal working hours and per schedule set by Owner. No Sunday work.
 - 2. Contractor be available to Owner and to property during normal working hours.
 - 3. Response Time to Owner request for maintenance: Twenty-four hours or less.
 - 4. Leaf removal will be included.
- B. Continuing Maintenance Proposal: Provide a continuing maintenance proposal from Installer to Owner, in the form of a one year maintenance agreement, starting on date maintenance service is initiated. Maintenance services start date to be date of Substantial Completion of entire project. State services, obligations, conditions, and terms for agreement period and for future renewal options. Maintenance agreement does not relieve Contractor from any of its responsibilities under warranty provisions identified in the general conditions and in Division 32.
- C. Initial Maintenance Service for Trees, Shrubs, Perennials, Native plugs and Bulbs: Provide full maintenance by skilled employees of Landscape Maintenance Contractor. Maintain as required in 3.1 Quality Standard. Begin Maintenance immediately after each area is planted and continue until plantings are acceptably healthy and well established and a satisfactory landscape is established, but for not less than maintenance period below.
 - 1. Maintenance Period: 12 months from date of Substantial Completion.
 - 2. If a satisfactory landscape has not been established, another inspection will be made upon written Contractor request, but no earlier than 30 calendar days

thereafter, that the landscape is ready for re-inspection.

3. Watering: Maintain irrigation system and provide adequate water for plant and turf grass establishment. The Maintenance Contractor is responsible for Irrigation Start-Up and Shut Down of the irrigation system. If necessary, Contractor will make delivery of all necessary equipment to the site to ensure plant material is watered adequately. Provide and maintain uniformly moist tree root balls during establishment. Provide water as needed to maintain the health of the plants.
 4. Weeding: Perform regular checks of beds in order to remove weed species.
 5. Mulch Cultivation: Maintain uniform depth per specifications of organic mulch in planting beds at all times.
- D. Maintenance and Inspection Schedule: Contractor and Owner will negotiate time for which Contractor will provide on-site landscape maintenance service. Contractor must have representatives on-site on dates and times determined in Owner/Contractor negotiations. Contractor will provide written schedule to Owner prior to starting landscape maintenance services and Owner and Contractor will participate in a monthly site review and inspection walk- through.

PART 2 - PRODUCTS

2.01 MATERIAL

- A. Fertilizer: Post-emergent fertilizer materials for turf grass and trees and shrubs, as required by each variety of plant material.
- B. Water: Clean, fresh and free of substances or matter which could inhibit vigorous growth of grass and plant materials.
- C. Herbicide: Comply with all applicable State and Federal regulations. Provide organic-based herbicides.
- D. Organic Mulch: See SECTION 32 9116 MULCH.

2.02 EQUIPMENT

- A. Provide all equipment necessary to achieve satisfactory maintenance levels for all plant material installations. There will not be space available on-site for the storage of equipment and supplies.

PART 3 - EXECUTION

3.01 QUALITY STANDARD

- A. Perennials:
 1. Perennials are to be maintained in good to excellent condition.
 2. Perennials are to be free of weeds, litter, and plant debris.

3. Perennials are to appear clean, neat, and trimmed of dead, broken, or diseased branches.
4. Perennials are to be free of pests.
5. Deadhead flowering perennials after each species is done flowering and remove all debris and clippings. Prune off any damage done to perennials by late frosts or declining foliage. Stake plants as necessary to keep them off of surrounding walks.
6. Each early spring, cut all perennial/ornamental grasses down to a height of 6" above grade and remove all debris and clippings prior to the emergence of spring flowering bulbs.

B. Trees:

1. Pruning of trees to be done on an as needed basis only and under the direction of the Arborist, unless otherwise requested by the Owner. Remove only dead, dying or broken branches. Unless otherwise indicated by Architect, do not cut tree leaders; remove only injured or dead branches from flowering trees. Prune to retain natural character and to keep clear of surrounding walks.
 - a. Trees are to be maintained in good to excellent condition.
 - b. Trees are to appear clean, neat, and well-trimmed with no dead, broken, or diseased limbs.
 - c. Trees are to be free of pests.
 - d. Dead or dying trees are to be replaced with the same tree type when conditions allow- replace within two weeks.
 - e. Promptly treat any accidental damage done to trees according to standard horticultural practice.
 - f. Remove leaves as needed to keep lawns, parking lots, and sidewalks clear of debris.
 - g. Remove stakes and guy wires 12 months after installation unless directed otherwise by Owner. Remove any remaining tree wrappings after the first growing season.

C. Shrubs and Ground Covers:

1. Pruning of shrubs to be done on an as needed basis only, unless otherwise requested by the Owner. Remove only dead, dying or broken branches. Prune shrubs to retain natural character and to keep clear of surrounding walks.
 - a. Shrubs and ground covers are to be maintained in good to excellent condition.
 - b. Shrubs and ground covers are to be free of weeds, litter, and plant debris.

- c. Shrubs and ground covers are to appear clean, neat, and trimmed of dead, broken, or diseased branches. Unless otherwise specified, shrubs and groundcovers are to be left in their natural form.
- d. Dead or dying shrubs are to be replaced with the same type when conditions allow - replace within two weeks.
- e. Shrubs and ground covers are to be free of pests.

D. Lawn:

- 1. Lawn areas are to be healthy green in color.
- 2. Lawn areas are to have no dry spots.
- 3. Lawn areas are to be mowed at a uniform height and appearance.
- 4. Lawn edges are to be trimmed back to the sidewalk edge and are flush or no more than one inch below adjacent sidewalks and mow strips.
- 5. Lawn around tree base is to be cut back leaving bare soil around most trees.
- 6. No weeds may be present.
- 7. Sprinkler heads are to be at or slightly below lawn level.
- 8. Lawn is of uniform makeup in type, size and texture.

E. Irrigation System:

- 1. The irrigation system is to operate as designed for the conditions of the site.
- 2. Zones are to be separated based on watering needs of plants, soil types, slopes, and solar exposure.
- 3. The system must perform with matched precipitation rates, uniform distribution, and head to head coverage.
- 4. There must be no broken equipment or sprinkler heads and the automatic electronic signaling is to operate without problem.
- 5. The water for the landscape is to be relatively clean and pose no threat to public health and safety.
- 6. The water is to contain no element that will inhibit plant health or stain hard surfaces, and is to be odor free.
- 7. The system is not irrigating onto sidewalks, driveways, and parking lots or spray on any buildings.

F. Hard Surfaces (Walkways, Curbs, Gutters, and Parking Areas):

1. Hard surfaces are to be kept free of loose debris and live vegetation.
2. For parking areas, there must not be potholes, all longitudinal and block cracks are sealed, all markings clearly distinguishable and visible, and there will be no raveling or spalling present.
3. For walkways, curb, and gutters, they will be kept free from cracks, spalling, and chips have no trip hazards, and repairs are to be done in a workmanlike manner.
4. Walks and parking areas are to be free of ice during working hours.

G. Site Drainage:

1. Drains, basins and pipe are to be clean and free of debris.
2. Clean-outs must function properly and be free of debris.
3. No water may flow onto adjacent properties.
4. Drainage basins are to be kept clean of garbage and other debris.
5. Retention/detention basins are to be kept to design capacity. Excess dirt must be removed as soon as possible.
6. Standing water is to be removed as soon as local codes permit.

3.02 MAINTENANCE SERVICE

- A. Maintain plantings by pruning, cultivating, watering, weeding, fertilizing, deadheading, restoring planting saucers, adjusting and repairing stakes and guy supports and root-ball stabilization, and resetting to proper grades or vertical position, as required to establish healthy, viable plantings. Spray or treat as required to keep trees and shrubs free of insects and disease. Restore or replace damaged tree wrappings as they loosen and deteriorate.
- B. Dispose of pruning waste (green waste) offsite at a proper waste facility.
- C. Keep all planting beds free of debris and trash. Dispose of properly offsite.
- D. Soil Analysis Report: Furnish one soil analysis report by a qualified independent soil testing laboratory stating soil mix's suitability for plant growth, percentages of organic matter, gradations of sand, silt, and clay content, cation exchange capacity, deleterious material, pH, soluble salt content and mineral and plant-nutrient content. Perform soil analysis prior to fertilization of plant material to determine necessity. Provide separate soil samples for the following areas/locations: turf, shrub, and flower bed areas. Test and provide report 30 days prior to end of maintenance period.
- E. Trees and plant material must be fertilized using specified fertilizer as described in Division 32 section "Plants." Fertilize in April and October. Fertilize in accordance with manufacturer's written instructions and grower's recommendations.
- F. Perform regular checks of groundcover and perennial beds for proper mulch and soil moisture levels in order to help determine any plant material growth problems. Any dead

spots or bare areas may require hand tilling of planting bed soil, addition of soil amendment (manufactured topsoil), addition of mulch of organic compost or complete plant material replacement.

G. Irrigation System:

1. The original irrigation design drawings and specifications, with approved design changes, are to be the basis for the irrigation system layout.
2. A qualified irrigation system consultant is to assist in determining the maintenance services of the irrigation system. The consultant is to inspect the irrigation system annually. The following guidelines are to be followed in determining the required services:
 - a. The irrigation schedule is to conform to the watering needs of the season.
 - b. The irrigation schedule is to be reviewed periodically to prevent over watering.
 - c. The irrigation schedule is to be managed to provide proper coverage without run-off.
 - d. The irrigation system is to be reviewed periodically to ensure uniform coverage during operation.
 - e. The irrigation system is not operating when it is raining.
 - f. The irrigation system is to operate during pre-dawn hours to reduce development of plant disease and evaporation.
 - g. The irrigation system components are to be repaired and/or replaced with the same components immediately.
 - h. An effort is to be made to install locally available commercial grade irrigation components.
 - i. Check system after mowing. Broken system parts must be fixed immediately or the water is to be turned off in that location until they can be fixed.

3.03 CLEAN UP AND PROTECTION

- A. Protect exterior plants from damage due to landscape operations, operations by other contractors and trades, and others. Maintain protection during maintenance periods. Promptly treat, repair or replace damaged plantings.

END OF SECTION

SECTION 32 11 23
AGGREGATE BASE

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Furnish all labor, materials, equipment, tools and services required to fully complete all Aggregate Base work as required by the Drawings and/or specified herein including, but not limited to, the following described items:
 - 1. Aggregate Base for:
 - a. Miscellaneous exterior concrete (sidewalks, curb, gutter, and equipment pads).
 - b. Concrete paving.

1.02 RELATED REQUIREMENTS:

- A. Section 01 11 00 – Summary of Work
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) Requirements
- B. Section 01 12 00 – Multiple Contract Summary for multiple contracts,
- C. Section 03 30 00 – Cast-In-Place Structural Concrete.
 - 1. Furnishing of vapor retarder and seam tape.
- D. Section 31 05 00 – Common Earthwork Requirements.
 - 1. General procedures and requirements for earthwork.
 - 2. Pre-Installation conference held jointly with other common earthwork related sections.
- E. Section 31 22 13 – Rough Grading.
- F. Section 31 22 16 – Fine Grading (for subgrade procedures).
- G. Section 31 23 23 – Fill (for compaction procedures and tolerances).
- H. Section 32 13 13 – Concrete Paving.

1.03 DEFINITIONS

- A. Aggregate:
 - 1. Aggregate: A hard inert mineral material, such as gravel, crushed rock, slag, or sand.

2. Coarse Aggregate: Aggregate retained on No. 8 (2.36 mm) sieve.
3. Dense-Graded Aggregate: Aggregate that is graded from maximum size down through filler with object of obtaining an asphalt mix with controlled void content and high stability.
4. Fine Aggregate: Aggregate passing No. 8 (2.36 mm) sieve.
5. Reclaimed Asphalt Pavement (RAP): Existing asphalt mixture that has been pulverized, usually by milling, and is used like an aggregate in recycling of asphalt pavements.

B. Gravel:

1. Gravel: Material passing 75.0-mm (3 inch) sieve and retained on 4.75-mm (No. 4) sieve.
2. Coarse gravel: Material passing 75.0-mm (3 inch) sieve and retained on 19.0-mm (3/4 inch) sieve.
3. Fine Gravel: Material passing 19.0-mm (3/4 inch) sieve and retained on 4.75-mm (No. 4) sieve.
4. Maximum Size (of aggregate) – In specifications for, or description of aggregate, smallest sieve opening through which entire amount of aggregate is required to pass.
5. Nominal Maximum Size (of aggregate) – In specifications for, or description of aggregate smallest sieve opening through which entire amount of aggregate is permitted to pass.
6. Sand:
 - a. Sand: Material passing 4.75-mm (No. 4) sieve and retained on 0.075-mm (No. 200) sieve.
 - b. Coarse Sand: Material passing 4.75-mm (No. 4) sieve and retained on 2.00-mm (No. 10) sieve.
 - c. Medium Sand: Material passing 2.00-mm sieve (No. 10) and retained on 0.475-mm (No. 40) sieve.
 - d. Fine Sand: Material passing 0.475-mm (No. 40) sieve and retained on 0.075-mm (No. 200) sieve.
 - e. Maximum Size (of aggregate) – In specifications for, or description of aggregate, smallest sieve opening through which entire amount of aggregate is required to pass.
 - f. Nominal Maximum Size (of aggregate) – In specifications for, or description of aggregate, smallest sieve opening through which entire amount of aggregate is permitted to pass.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Pre-Installation Conferences:

1. Participate in Mandatory pre-installation conference as specified in Section 31 05 00.
2. In addition to agenda items specified in Section 01 31 00 and Section 31 05 00, review the following:
 - a. Review requirements and frequency of testing and inspections.
 - b. Review termite control application requirements (if used).
 - c. Review aggregate base installation requirements.
 - d. Review vapor retarder installation requirements.
 - e. Review proposed miscellaneous exterior concrete schedule.
 - f. Review proposed concrete paving schedule.
 - g. Review Section 01 45 23 for Testing and Inspection administrative requirements and responsibilities and Field Quality Control tests and inspections required of this section.
 - (1) Review frequency of testing and inspections.

B. Sequencing:

1. Compaction as described in Section 31 22 16 – Fine Grading.
2. Termite Control: (if used)
 - a. Application Option A:
 - (1) Apply termite protection on top of soil base before aggregate base and vapor retarder is installed.
 - b. Application Option B:
 - (1) Install vapor retarder after application of termite protection on top of aggregate base.
3. Exterior Footings and Foundations are Installed.
4. Aggregate Base:
 - a. Install aggregate base at location shown in Contract Drawings.

C. Scheduling:

1. Interior slab-on-grade concrete:
 - a. Notify Architect twenty-four (24) hours minimum before installation of concrete to allow inspection of vapor retarder installation.
 - b. Notify Testing Agency and Architect twenty-four (24) hours minimum before installation of interior concrete slabs to allow inspection of aggregate base.
 - c. Allow special inspector to review all sub grades and excavations to determine if building pad has been prepared in accordance with geotechnical report prior to placing any aggregate base.
2. Miscellaneous Exterior Concrete:
 - a. Notify Testing Agency and Architect twenty-four (24) hours minimum before placing concrete for exterior site work concrete (sidewalks, curbs, gutters, etc.), footings, foundation walls, and building slabs to allow inspection of aggregate base.
3. Concrete Paving:
 - a. Notify Testing Agency and Architect twenty-four (24) hours minimum before placing aggregate base to allow inspection of aggregate base.

1.05 SUBMITTALS

A. Closeout Submittals:

1. Include the following in Operations and Maintenance Manual specified in Section 01 78 00:
 - a. Record Documentation:
 - (1) Testing and Inspection Reports:
 - Testing Agency Testing and Inspection Reports of aggregate base.

1.06 QUALITY ASSURANCE

A. Testing and Inspection:

1. Owner will provide Testing and Inspection for aggregate base:
 - a. Owner is responsible for Quality Assurance. Quality Assurance performed by Owner will be used to validate Quality Control performed by Contractor.
 - b. Owner will employ testing agencies to perform testing and inspection for aggregate base as specified in Field Quality Control in Part 3 of this specification.

- (1) Owner's employment of an independent Testing Agency does not relieve Contractor of Contractor's obligation to perform the Work in strict accordance with requirements of Contract Documents and perform contractor testing and inspection.
- (2) See Section 01 12 00 – Multiple Contract Summary.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Acceptance Requirements:

1. Materials shall be delivered in original, unopened packages with labels intact.

1.08 FIELD CONDITIONS

A. Ambient Conditions:

1. Do not perform work during unfavorable conditions as specified below:
 - a. Aggregate Base:
 - (1) Presence of free surface water.
 - (2) Over-saturated sub base materials.
 - b. Vapor Retarder:
 - (1) Unacceptable conditions for installation include presence of high winds which would tear or damage vapor retarder.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Aggregate Base"

1. Under Interior Slab-On-Grade Concrete (Section 03 30 00 – Cast-In-Place Structural Concrete).
 - a. New Aggregate Base:
 - (1) Gravel: 3/4 inch (18 mm) minimum to one inch 25 mm maximum well-graded, clean gravel or crushed rock.
 - (2) Base type gravel or crushed rock, graded by weight as follows (three-quarter to one inch, clean gap-graded gravel):
 - Road Base type gravel or crushed stone (slag not allowed), graded as follows:
 - Percent of Weight Passing
(25.4 mm): 100

(19.0 mm): 90-80

(12.7 mm): 20-40

(9.5 mm): 5-10

(4.75 mm): 0-12

2. Under Exterior Concrete (Section 03 30 00 – Cast in Place Structural Concrete):
 - a. New Aggregate Base:
 - (1) Road Base to conform to State DOT Specifications.

PART 3 - EXECUTION

3.01 PREPARATION

A. Stockpiles:

1. Provide area for each stockpile of adequate size, reasonably uniform in cross-section, well drained, and cleared of foreign materials.
2. Locate piles so that there is no contamination by foreign material and not intermingling of aggregates from adjacent piles. Do not use steel tracked equipment on stockpiles.
3. Do not store aggregates from different sources, geological classifications, or of different gradings in stockpiles near each other unless bulkhead is placed between different materials.
4. Do not use washed aggregates sooner than twenty-four (24) hours after washing or until surplus water has drained out and material has uniform moisture content.
5. Do not stockpile higher than 15 feet. Cover or otherwise protect stockpiles for use in HMA to prevent buildup of moisture.

B. Surface Preparation (Miscellaneous Exterior concrete):

1. Subgrade:
 - a. Finished grade to grades required by Contract Documents.
 - b. Compact subgrade as specified in Section 31 23 23.

C. Surface Preparation (Concrete Paving):

1. Subgrade:
 - a. Finish grade parking surface area to grades required by Contract Documents.
 - b. Aggregate base and paving must be placed before any moisture or seasonal

changes occur to subgrade that would cause compaction tests previously performed to be erroneous. Recompact and retest subgrade soils that have been left exposed to weather.

3.02 INSTALLATION

A. Aggregate Base:

1. General:

- a. Do not place aggregate base material when subgrade is frozen or unstable.
- b. Spread aggregate base material with equipment except in limited or restricted areas where use of hand spreading is allowed.
- c. Spread aggregate base material in manner that does not break down material and eliminates segregation, ruts, and ridges.
- d. Correct damage to aggregate base caused by construction activities and maintain corrected aggregate base until subsequent course is placed.
- e. Do not allow traffic on aggregate base.
- f. Remove all standing storm water.

2. Under miscellaneous exterior concrete aggregate base:

- a. Except under mow strips, place 4 inches (100 mm) minimum of aggregate base, level, and compact as specified in Section 31 23 23.

3. Concrete paving aggregate base:

- a. Standard Duty Concrete Paving & Gravel Surface: 6" thick minimum after compaction in accordance with Contract Drawings.
- b. Heavy Duty Concrete Paving: 8" thick minimum after compaction in accordance with Contract Drawings.
- c. Concrete Sidewalk: 4" thick minimum after compaction in accordance with Contract Drawings.
 - (1) Compact to ninety-five (95) percent minimum density as determined by ASTM D1557.
 - (2) Recompact unprimed aggregate base if it receives precipitation before paving is laid.
 - (3) Remove or repair improperly prepared areas as directed by Architect.

B. Tolerances:

1. Concrete Paving Areas:

- a. Measure using string line from curb to curb, gutter, flat drainage structure or grade break.
- b. Finished base course shall be true to line and grade within plus or minus 1/4 inch in 10 feet (6 mm in 3 meters).
- c. Maximum variation from required grades shall be 1/10 of one foot (28 mm).

3.03 FIELD QUALITY CONTROL

A. Field Tests and Inspections:

1. Civil and structural field tests, laboratory testing, and inspections are provided by Owner's independent Testing Agency as specified in Section 01 45 23 – Testing and Inspection Services:

a. Quality Control is sole responsibility of Contractor.

- (1) Owner's employment of an independent Testing Agency does not relieve Contractor of Contractor's obligation to perform testing and inspection as part of his Quality Control:

- Testing and Inspections, if performed by Contractor, will be responsibility of Contractor to be performed by an independent entity.

2. Aggregate Base:

a. Miscellaneous exterior concrete areas:

- (1) Testing Agency shall provide testing and inspection for exterior aggregate base.

- (2) Number of tests may vary at discretion of Architect.

- (3) Testing Agency will test compaction of base in place according to ASTM D1556/D1556M, ASTM D2167, and ASTM D6938, as applicable. Tests will be performed at following frequency:

- Sitework Areas: One test for every 10,000 sq. ft. (930 sq. m) or less of exterior pads area but no fewer than three tests.

b. Concrete paving area:

- (1) Testing Agency shall provide testing and inspection for exterior aggregate base.

- (2) Number of tests may vary at discretion of Architect.
- (3) Testing Agency will test compaction of base in place according to ASTM D1556/D1556M, ASTM D2167, and ASTM D698, as applicable. Tests will be performed at following frequency:
 - Sitework Areas: One test for every 10,000 sq. ft. (930 sq. m) or less of pavement area but no fewer than three tests.

END OF SECTION 32 11 23

SECTION 32 13 13
CONCRETE PAVING

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Furnish all labor, materials, equipment, tools and services required to fully complete all Concrete Paving work as required by the Drawings and/or specified herein including, but not limited to, the following described items.
 - 1. Driveways and roadways.
 - 2. Curbs and flat drainage gutters.
 - 3. Walkways

1.02 RELATED REQUIREMENTS

- A. Section 01 11 00 – Summary of Work
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) Requirements
- B. Division 03 Section “Cast-In-Place Concrete” for general building applications of concrete.
- C. Division 31 Section “Earth Moving” for subgrade preparation, grading, and subbase course.

1.03 DEFINITIONS

- A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash and other pozzolans, and ground granulated blast-furnace slag.

1.04 SUBMITTALS

- A. Product Data: For each type of manufactured material and product indicated.
- B. Shop Drawings: Joint layout plan for written approval before starting work on this Section.
- C. Design Mixtures: For each concrete pavement mixture. Include alternative mixture designs when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
- D. Qualification Data: For manufacturer.
- E. Material Test Reports: From a qualified testing agency indicating and interpreting test results for compliance of the following with requirements indicated, based on comprehensive testing of current materials:

1. Aggregates. Include service record data indicating absence of deleterious expansion of concrete due to alkali-aggregate reactivity.
- F. Material Certificates: Signed by manufacturers certifying that each of the following materials complies with requirements:
1. Cementitious materials.
 2. Steel reinforcement and reinforcement accessories.
 3. Fiber reinforcement.
 4. Admixtures.
 5. Curing compounds
 6. Bonding agent or epoxy adhesive
 7. Joint fillers.
- G. Field quality-control test reports.
- H. Minutes of preinstallation conference.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Manufacturer of ready-mixed concrete products who complies with ASTM C 94/C 94M requirements for production facilities and equipment.
1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities".
- B. ACI Publications: Comply with ACI 301, "Specifications for Structural Concrete", unless modified by requirements in the Contract Documents.
- C. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixtures.
- D. Mockups: Cast mockups of full-size sections of concrete pavement to demonstrate typical joints, surface finish, texture, color, and standard of workmanship.
1. Build mockups in the location and of the size indicated or, if not indicated, as directed by Architect.
 2. Notify Architect seven days in advance of dates and times when mockups will be constructed.
 3. Obtain Architect's approval of mockups before starting construction.
 4. Maintain approved mockups during construction in an undisturbed condition as a standard for judging the completed pavement.

5. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
- E. Pre-Installation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination".
1. Before submitting design mixtures, review concrete pavement mixture design and examine procedures for ensuring quality of concrete materials and concrete pavement construction practices. Require representatives, including the following, of each entity directly concerned with concrete pavement, to attend conference:
 - a. Contractor's superintendent.
 - b. Independent testing agency responsible for concrete design mixtures.
 - c. Ready-mix concrete producer.
 - d. Concrete pavement subcontractor.

1.06 PROJECT CONDITIONS

- A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.
- B. Do not perform work during unfavorable conditions as specified below:
1. Temperature below 50 deg F.
 2. Presence of free surface water.
 3. Over-saturated base and sub-base materials.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirement apply to product selection:
1. Products: Subject to compliance with requirements, provide one of the products specified.
 2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.02 FORMS

- A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, smooth exposed surfaces.
1. Use flexible or curved forms for curves with a radius of 100 feet or less.

- B. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.

2.03 STEEL REINFORCEMENT

- A. Plain-Steel Welded Wire Reinforcement: ASTM A185, fabricated from as-drawn steel wire into flat sheets.
- B. Reinforcing Bars: ASTM A 615/A 615M, Grade 60. Cut bars true to length with ends square and free of burrs.
- C. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded wire reinforcement, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete of greater compressive strength than concrete, and as follows:
 - 1. Equip wire bar supports with sand plates or horizontal runners where base material will not support chair legs.

2.04 CONCRETE MATERIALS

- A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source throughout the Project:
 - 1. Portland Cement: ASTM C 150, Type I/II, white. Supplement with the following:
 - a. Fly Ash: ASTM C 618, Class C or F.
- B. Normal-Weight Aggregates: ASTM C33, Class 4S coarse aggregate, uniformly graded. Provide aggregates from a single source with documented service record data of at least 10 years' satisfactory service in similar placement applications and service conditions using similar aggregates and cementitious materials.
 - 1. Road Base type gravel or crushed rock, graded as follows:
 - a. Percent by Weight Passing Sieve
 - (1) 100
 - (2) 85-100
 - (3) 45-60
 - (4) 30-50
 - (5) 5-10 (non-plastic)
- C. Water: ASTM C 94/C 94M.
- D. Air-Entraining Admixture: ASTM C 260.

- E. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.
 - 1. Water-Reducing Admixture: ASTM C 494-C 494M, Type A.
 - 2. Water- Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
 - 3. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
 - 4. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
 - 5. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

2.05 FIBER REINFORCEMENT

- A. Synthetic Fiber: Monofilament polypropylene fibers engineered and designed for use in concrete pavement, complying with ASTM C 1116, Type III, 1/2 to 1-1/2 inches long.
 - 1. Products:
 - a. Monofilament Fibers:
 - (1) Axim Concrete Technologies; Fibrasol IIP.
 - (2) Euclid Chemical Company; Fiberstrand 100.
 - (3) FORTA Corporation; Forta Mono.
 - (4) Grace, W.R. & Co.—Conn.; Grace MicroFiber.
 - (5) Metalcrete Industries; Polystrand 1000.
 - (6) SI Concrete Systems; Fibermix Stealth.
 - (7) Novomesh

2.06 CURING MATERIALS

- A. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighting approximately 9 oz./sq. yd. dry.
- B. Moisture-Retaining Cover: ASTM C 171, polyethylene film r white burlap-polyethylene sheet.
- C. Water: Potable.
- D. Concrete Densifier
 - 1. Ashford Formula

E. Evaporation Retarder: Waterborne, monomolecular film forming; manufactured for application to fresh concrete.

1. Products:

- a. Axim Concrete Technologies; Cimfilm.
- b. Burke by Edeco; BurkeFilm.
- c. ChemMasters; Spray-Film.
- d. Conspec Marketing & Manufacturing Co, Inc; Aquafilm.
- e. Dayton Superior Corporation; Sure Film.
- f. Euclid Chemical Company; Eucobar.
- g. Kaufman Products, Inc; Vapor Aid.
- h. Lambert Corporation; Lambco Skin.
- i. L&M Construction Chemicals, Inc.; E-Con.
- j. MBT Protection and Repair, ChemRex Inc.; Confilm.
- k. Meadows, W.R. Inc; Sealtight Evapre.
- l. Metalcrete industries; Waterhold.
- m. Nox-Crete Products Group, Kinsman Corporation; Monofilm.
- n. Sika Corporation, Inc; SikaFilm.
- o. Symons Corporatio; Finishing Aid.
- p. Vexcon Chemicals, Inc; Certi-Vex EnvioAssist.

F. White Waterborne Membrane-Forming Curing Compound: ASTM C 309, Type 2, Class B.

1. Products:

- a. Anti-Hydro International, Inc; AH Curing Compound #2 WP WB.
- b. Burke by Edoco; Resin Emulsion White.
- c. ChemMasters; Safe-Cure 2000.
- d. Conspec marketing & Manufacturing Co., Inc.; W.B. Resin Cure.
- e. Dayton Superior Corporation; Day-Chem White Pigmented Cure (J-10-W).

- f. Euclid Chemical Company; Kurez VOX White Pigmented.
- g. Kaufman Products, Inc.; Thinfilm 450.
- h. Lambert Corporation; Aqua Kure-White.
- i. L&M Construction Chemicals, Inc.; L&M Cure R-2.
- j. Meadows, W.R. Inc.; 1200-White.
- k. Symons Corporation; Resi-Chem White.
- l. Tamms Industries, Inc.; Horncure 200-W.
- m. Unitex; Hydro White.
- n. Vexcon Chemicals, Inc; Certi-Vex Enviocure White 100.

2.07 RELATED MATERIALS

- A. Expansion and Isolation joint Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber.
 - 1. 1/2 inch thick.
 - 2. Manufactured commercial fiber type:
 - a. Acceptable Products:
 - (1) Conflex by Masonite Building & Industrial Products Group
 - (2) Sealtight by WR Meadows Inc.
 - (3) Equal as approved by Architect before installation. See Section 01 60 00.
- B. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.
- C. Epoxy Bonding Adhesive: ASTM C 881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to requirements, and as follows:
 - 1. Type IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.

2.08 CONCRETE MIXTURES

- A. Prepare design mixtures, proportioned according to ACI 301, for each type and strength of normal-weight concrete determined by either laboratory trial mixes or field experience.
 - 1. Use a qualified independent testing agency for preparing and reporting proposed

concrete mixture design for the trial batch method.

- B. Proportion mixtures to provide normal-weight concrete with the following properties:
 - 1. Compressive Strength (28 Days):
 - a. Concrete Pavement, Curb, Swale, and Sidewalk: 3,500 psi.
 - b. Storm Sewer Structure (inlet or Junction Box): 3,000 psi.
 - c. All other site concrete: 4,000 psi.
 - 2. Maximum Water-Cementitious Materials Ratio at Point of Placement: 0.44.
 - 3. Slump Limit: 4 inches, plus or minus 1 inch.
- C. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete at point of placement having an air content as follows:
 - 1. Air Content: 6-1/2 percent plus or minus 1 percent for 1-inch nominal maximum aggregate size.
- D. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.
- E. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.
 - 1. Use water-reducing admixture high-range, water-reducing and retarding admixture, and plasticizing and retarding admixture in concrete, as required for placement and workability.
 - 2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
- F. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than Portland cement according to ACI 301 requirements for concrete exposed to deicing chemicals as follows:
 - 1. Fly Ash or Pozzolan: 20 percent.
- G. Synthetic Fiber: Add to concrete truck on site at mix rate specified on plans or per manufacturer's recommendations.

2.09 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M and ASTM C1116. Furnish batch certificates for each batch discharged and used in the Work.
 - 1. When air temperature is between 85 deg F. and 90 deg F, reduce mixing and delivery time from 1/12 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.
- B. Proof-roll prepared subbase surface below concrete pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding.
 - 1. Completely proof-roll subbase in one direction and repeat in perpendicular direction. Limit vehicle speed to 3 mph.
 - 2. Proof-roll with a loaded 10-wheel tandem axle dump truck weighing not less than 15 tons.
 - 3. Subbase with soft spots and areas of pumping or rutting exceeding a depth of 1/2 inch require correction according to requirements in Division 31 Section "Earth Moving".
 - 4. Verify that compactness is 98 percent minimum density as determined by ASTM D 689.
- C. Proceed with concrete pavement operation only after nonconforming conditions have been corrected and subgrade is ready to receive pavement.

3.02 PREPARATION

- A. Remove loose material from compacted subbase surface immediately before placing concrete.

3.03 EDGE FORMS AND SCREED CONSTRUCTION

- A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides for pavement to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.
- B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.
- C. Form vertical surfaces full depth. Do not allow concrete to flow out from under forms in any degree.

3.04 STEEL REINFORCEMENT

- A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.
- C. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position

during concrete placement. Maintain minimum cover to reinforcement.

- D. Install welded wire reinforcement in length as long as practicable. Lap adjoining pieces at least one full mesh, and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.
- E. Install fabricated bar mats in length as long as practicable. Handle units to keep them flat and free of distortions. Straighten bends, kinks, and other irregularities, or replace units as required before placement. Set mats for a minimum 2 inch overlap of adjacent mats.

3.05 JOINTS

- A. General: Form construction, isolation, and contraction joints and tool edgings true to line with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline, unless otherwise indicated.
 - 1. When joining existing pavement, place transverse joints to align with previously placed joints, unless otherwise indicated.
 - 2. Align joints of sidewalk and curb and gutter and concrete pavement.
- B. Construction Joints: Set construction joints at side and end terminations of pavement and at locations where pavement operations are stopped for more than one-half hour unless pavement terminates at isolation joints.
 - 1. Continue steel reinforcement across construction joints, unless otherwise indicated. Do not continue reinforcement through sides of pavement strips, unless otherwise indicated.
 - 2. Provide tie bars at sides of pavement strips where indicated.
 - 3. Butt joints: Use bonding agent at joint locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
 - 4. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt-coat one-half of dowel length to prevent concrete bonding to one side of joint.
- C. Isolation Joints: Form isolation joints of preformed joint filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, walks, other fixed objects, and where indicated.
 - 1. Locate expansion joints at intervals of 50 feet, unless otherwise indicated.
 - 2. Extend joint fillers full width and depth of joint.
 - 3. Terminate joint filler not less than 1/4 inch below finished surface if joint is not indicated.
 - 4. Place top of joint filler flush with finished concrete surface if joint sealant is not indicated.

5. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint filler sections together.
 6. Protect top edge of joint filler during concrete placement with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.
- D. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Depth of control joints shall be approximately one quarter of concrete slab thickness, but not less than one inch. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, as follows to match jointing of existing adjacent concrete pavement and concrete site elements:
1. Groove Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint with grooving tool to a 1/4 inch radius. Repeat grooving of contraction joints after applying surface finished. Eliminate groover marks on concrete surfaces.
 2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8 inch wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before developing random contraction cracks.
 3. Doweled Contraction Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt-coat one-half of dowel length to prevent concrete bonding to one side of joint.
 4. Scored Control joint Spacing (Unless Indicated Otherwise):
 - a. Curbs: 15 feet on center.
 - b. Sidewalks: 5 feet on center.
 - c. Flat Drainage Structures: 10 feet on center.
 - d. Retaining Walls: 6 feet on center.
- E. Edging: Tool edges of pavement, gutters, curbs, and joints in concrete after initial floating with an edging toll to a 1/4 inch radius. Repeat tolling of edges after applying surface finishes. Eliminate tool marks on concrete surfaces.

3.06 CONCRETE PLACEMENT

- A. Inspection: Before placing concrete, inspect and complete formwork installation, steel reinforcement, and items to be embedded or cast in. Notify other trades to permit installation of their work.
- B. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.

- C. Comply with ACI 301 requirements for measuring, mixing, transporting, and placing concrete.
- D. Do not add water to concrete during delivery or at Project site.
- E. Do not add water to fresh concrete after testing.
- F. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.
- G. Consolidate concrete according to ACI 301 by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping.
 - 1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand spreading and consolidation. Consolidate with care to prevent dislocating reinforcement, dowels, and joint devices.
- H. Place concrete in two operations; strike off initial pour for entire width of placement and to the required depth below finish surface. Lay welded wire fabric or fabricated bar mats immediately in final position. Place top layer of concrete, strike off, and screed.
 - 1. Remove and replace concrete that has been placed for more than 15 minutes without being covered by top layer or use bonding agent if approved by architect.
- I. Screed pavement surfaces with a straightedge and strike off.
- J. Commence initial floating using bull floats or darbies to impart an open textured and uniform surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.
- K. Sidewalks, Exterior Stairs, and Landings:
 - 1. Slope sidewalks with cross slope of 1/8 to 1/4 inch per ft in direction of intended drainage.
 - 2. Slope sidewalks away from building one percent minimum.
 - 3. Do not dust with cement.
- L. Curbs and Gutters: When automatic machine placement is used for curb and gutter placement, submit revised mix design and laboratory test results that meet or exceed requirements. Produce curbs and gutters to required cross section, lines, grades, finish, and jointing as specified for formed concrete. If results are not approved, remove and replace with formed concrete.
- M. When adjoining pavement lanes are placed in separate pours, do not operate equipment on concrete until pavement has attained 85 percent of its 28-day compressive strength.
- N. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work

from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.

1. When air temperature has fallen to or is expected to fall below 40 deg F, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F and not more than 80 deg F at point of placement.
 2. Do not use frozen materials or materials containing ice or snow.
 3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mix designs.
- O. Hot-Weather Placement: Comply with ACI 301 and as follows when hot-weather conditions exist:
1. Cool ingredients before mixing to maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
 2. Cover steel reinforcement with water-soaked burlap so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
 3. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.
- P. Remove or repair improperly prepared areas as directed by Architect.

3.07 FLOAT FINISHING

- A. General: Do not add water to concrete surfaces during finishing operations.
- B. Float Finish: Begin the second floating operation when bleed-water sheen has disappeared, and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats, or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.
1. Medium-to-Fin-Textured Broom Finish: Draw a soft bristle broom across float-finished concrete surface perpendicular to line of traffic to provide a uniform, fine-line texture. Edges to be rounded and edger marks removed.
 - a. Applies to curbs, gutters, sidewalks, flat drainage structures, stairs, and miscellaneous concrete site elements.
 2. Smooth-Rubbed Finish: Not later than one day after form removal, moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture. Do not apply cement grout other than that created by the rubbing process.

3.08 CONCRETE PROTECTION AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.
- B. Comply with ACI 306.1 for cold-weather protection.
- C. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2lb/sq.ft. x h before and during finishing operations. Apply according to manufacturer's written instruction after placing, screeding, and bull floating or darbying concrete, but before float finishing.
- D. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.
- E. Curing Methods: Cure concrete by moisture curing, moisture-retaining-cover curing, curing compound, or a combination of these as follows:
 - 1. Moist Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
 - a. Water.
 - b. Continuous water-fog spray.
 - c. Absorptive cover, water saturated and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.
 - 2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
 - 3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

3.09 PAVEMENT TOLERANCES

- A. Comply with tolerances of ACI 117 and as follows:
 - 1. Elevation: 1/4 inch.
 - 2. Thickness: Plus 3/8 inch, minus 1/4 inch.
 - a. Finished Base Course Minimum Thickness (after compaction and true to line and grade plus or minus 1/4 inch in 10 feet):
 - (1) Standard Duty concrete Paving: 6 inches thick.

- (2) Concrete Sidewalk: 4 inches thick.
- b. Paving Thickness Minimum:
 - (1) Standard Duty Concrete Paving: 4 inches thick.
 - (2) Heavy Duty Concrete Paving: 6 inches thick.
 - (3) Concrete Sidewalk: 4 inches thick.
- 3. Surface: Gap below 10-foot long, unlevelled straightedge not to exceed 1/4 inch.
- 4. Lateral Alignment and Spacing of Tie Bars and Dowels: 1 inch.
- 5. Vertical Alignment of Tie Bars and Dowels: 1/4 inch.
- 6. Alignment of Tie-Bar End Relative to Line Perpendicular to Pavement Edge: 1/2 inch.
- 7. Alignment of Dowel-Bar End Relative to Line Perpendicular to Pavement Edge: Length of dowel 1/4 inch per 12 inches,
- 8. Joint Spacing: 3 inches.
- 9. Contraction Joint Depth: Plus 1/4 inch, no minus.
- 10. Joint Width: Plus 1/8 inch, no minus.

3.10 FIELD QUALITY CONTROL

- A. Architects Observation: To allow Architect's verification of grades and elevations, notify Architect three days minimum before placing concrete for specified concrete site elements.
- B. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.
- C. Testing Services: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:
 - 1. Testing Frequency: Obtain at least 1 composite sample for each 100 cu. yd. or fraction thereof for each concrete mix placed each day.
 - a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
 - 2. Slump: ASTM C 143/C 143 M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mix. Perform additional tests when concrete consistency appears to change.
 - 3. Air Content: ASTM C 231, pressure method; one test for each composite sample,

but not less than one test for each day's pour of each concrete mix.

4. Concrete Temperature: ASTM C 1064; one test hourly when temperature is 40 deg F and below and when 80 deg F and above, and one test for each composite sample.
 5. Compression Test Specimens: ASTM C 31/C 31M; cast and laboratory cure one set of three standard cylinder specimens for each composite sample.
 6. Compressive-Strength Tests: ASTM C 39/C 39M; test 1 specimen at 7 days and 2 specimens at 28 days.
 - a. A compressive-strength test shall be the average compressive strength from 2 specimens obtained from same composite sample and tested at 28 days.
- D. Strength of each concrete mix will be satisfactory if average of any 3 consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.
- E. Test results shall be reported in writing to Architect, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.
- F. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive devise may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.
- G. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect.
- H. Remove and replace concrete pavement where test results indicate that it does not comply with specified requirements.
- I. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.11 REPAIRS AND PROTECTION

- A. Remove drips, overspray, improper markings, and paint material tracked by traffic by sand blasting, wire brushing, or other method approved by Architect before performance.
- B. Remove and replace concrete pavement that is broken, damaged, or defective or that does not comply with requirements in this Section.
- C. Drill test cores, where directed by Architect, when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory pavement areas with

portland cement concrete bonded to pavement with epoxy adhesive.

- D. Protect concrete from damage. Exclude traffic from pavement for at least 14 days after placement. When construction traffic is permitted, maintain pavement as clean as possible by removing surface stains and spillage of materials as they occur.
- E. Maintain concrete pavement free of stains, discoloration, dirt, and other foreign material. Sweep concrete pavement not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION 32 13 13

SECTION 32 17 23
PAVEMENT MARKINGS

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Furnish all labor, materials, equipment, tools and services required to fully complete all Pavement Marking work as required by the Drawings and/or specified herein including, but not limited to, the following described items.
 - 1. Furnish material and apply pavement and curb markings as described in Contract Documents, including general painted pavement markings, fire lane marking, and handicapped symbol painting.

1.02 RELATED REQUIREMENTS

- A. Section 01 11 00 – Summary of Work
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) Requirements

1.03 QUALITY ASSURANCE

- A. Regulatory Requirements: Paint handicap spaces to conform to ADA Standards and local code requirements.

1.04 PROJECT CONDITIONS

- A. Project Environmental Requirements:
 - 1. Apply only on dry surfaces, during favorable weather in accordance with manufacturer’s recommendations, and when damage by rain, fog, or condensation not anticipated.

PART 2 - PRODUCTS

2.01 MATERIAL

- A. Paint:
 - 1. Federal Highway Administration Approved. Paint shall be Promar alkyd traffic marking paint, manufactured by Sherwin Williams, factory mixed, quick-drying, non-bleeding.
 - 2. Equal as approved by Architect before application. See Section 01 62 00.
- B. The following items are to be painted with the colors noted below:
 - 1. Blue and White (refer to detail on drawings)
 - 2. Color as selected.

3. White.
4. Red with white letters.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Architect.
- B. Do not apply acrylic latex system until paving has cured 7 days minimum. Do not apply alkyd or chlorinated rubber systems until paving has cured 3 months minimum.
- C. Surfaces shall be dry and free of grease and loose dirt particles. Scrape and wire brush chipped or damaged paint on existing curbs.
- D. Perform layout with chalk or lumber crayon only.

3.02 APPLICATION

- A. Site Tolerances:
 1. General: Make lines parallel, evenly spaced and with sharply defined edges.
 2. Line Widths:
 - a. Plus or minus 0.25 inch variance on straight segments.
 - b. Plus or minus 0.50 inch variance on curved alignments.
- B. Provide two coat application, each coat applied at 150 sq. ft. per gal. Apply second coat after three hours minimum or when first coat is thoroughly dried, whichever is longer.

3.03 CLEANING

- A. Remove drips, overspray, improper markings, and paint material tracked by traffic by sand blasting, wire brushing, or other method approved by Architect before performance.

END OF SECTION 32 17 23

SECTION 32 84 00
IRRIGATION SYSTEM

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Furnish all labor, materials, equipment, tools and services required to fully complete all Irrigation work as is indicated on the drawings and/or specified herein including, but not limited to, the following described items.
 - 1. Refer to "PART 2 – PRODUCTS" for all Buy America Build America Act (BABA) Requirements.
 - 2. Any minor items of labor or materials not specifically noted on the drawings or specifications, but obviously necessary for the proper completion of the work, are to be considered as incidental to and included in the contract.

1.02 QUALITY ASSURANCE

- A. Permits and Fees: Obtain and pay for all permits required.
- B. Manufacturer's Specifications: Follow Manufacturer's current printed specifications and drawings in all cases where such directions cover points not specified or shown in the Drawings.
- C. Ordinances and Regulations: All local, municipal and state laws, codes, and regulations governing or relating to all portions of this work are hereby incorporated into and made a part of these Specifications. Anything contained in these Specifications shall not be construed to conflict with any of the above codes, regulations, or requirements of the same. However, when these Specifications and Drawings call for or describe materials, workmanship, or construction of a better quality, higher standard, or larger size than is required by the above codes and regulations, the provisions of these Specifications and Drawings shall take precedence.
- D. Explanation of Drawings:
 - 1. Due to the scale of the Drawings, it is not possible to indicate all offsets, fittings, sleeves, etc., which may be required. Carefully investigate the conditions affecting all of the work and plan accordingly, and furnish all required fittings. Install system in such a manner to avoid conflicts with planting, utilities, and architectural features.
 - 2. The irrigation plans are drawn diagrammatically, including piping and equipment locations. Contractor shall make minor adjustments as required to avoid physical elements and conform to the site conditions. Do not install the irrigation system as shown on the Drawings when it is obvious in the field that obstructions, grade differences, utility conflicts, planting conflicts, drainage problems or discrepancies in dimensions exist that might not have been considered in engineering. Bring such obstructions or differences to the attention of the Landscape Architect. In the event

this notification is not given, the Contractor shall assume full responsibility for any revision necessary. In all cases, contractor shall insure that there are no conflicts between the irrigation systems, planting (existing and proposed) and existing utilities.

E. Qualifications:

1. Sprinkler Installation Company:

- a. Produce certification of the following requirements prior to beginning work of this Section:
- b. In irrigation system installation business for five years minimum providing quality of labor and materials described in Contract Documents.
- c. Evidence of completing ten projects minimum of scope and quality equal to this project and in timely manner.
- d. Certifiable list of suppliers from whom it will be obtaining materials used on this project.
- e. Evidence that it utilizes employees with specified experience and in quantity sufficient to perform work of this Section within time limits established by Contract.

2. Workers: Use only trained personnel familiar with required irrigation system installation procedures.

- a. Perform installation under direction of foreman or supervisor with five years minimum experience in sprinkling system installations.

F. Regulatory Requirements: Work and materials shall be in accordance with latest rules and regulations, and other applicable state or local laws. Nothing in Contract Documents is to be construed to permit work not conforming to these codes.

G. Pre-Installation Conference: Schedule pre-installation conference after excavation of trenches and installation of sleeves, but before installation of pipe. Notify Owner's representative, Landscape Architect and General Contractor fourteen minimum of (14) days prior to scheduled start date for such meeting.

1.03 SUBMITTALS

A. Materials List:

1. Within ten (10) days after the award of the Contract, submit six (6) copies of the complete lists of materials proposed for installation, and obtain the Landscape Architect's written approval thereof before proceeding. Use only accepted materials and items of equipment.
2. List all materials by manufacturer's name and model number.

B. Manuals:

1. Prior to the final acceptance of the irrigation system, furnish three (3) individually bound Service Manuals to the Landscape Architect for use by the Owner. The manuals shall contain complete enlarged drawings, diagrams and spare parts lists of all equipment installed showing manufacturer's name and address. In addition, each Service Manual shall contain the following:
 - a. Index sheet indicating the Contractor's name, address and phone number.
 - b. Copies of equipment warranties and certificates.
 - c. List of equipment with names, addresses and telephone numbers of all local manufacturer's representatives.
 - d. Complete operating and maintenance instructions in sufficient detail to permit operating personnel to understand, operate and maintain all equipment.

C. Record Drawings:

1. Dimension from two (2) permanent points of reference, building corners, sidewalk, or road intersections, etc., the location of the following items:
 - a. Connection to existing water lines.
 - b. Connection to electrical power.
 - c. Controller.
 - d. Control wires.
 - e. Gate valves.
 - f. Routing of sprinkler pressure lines.
 - g. Routing of lateral sprinkler non-pressure lines.
 - h. Remote control valves.
 - i. Routing of control valves.
 - j. Quick coupling valves.
 - k. All sleeve locations.
 - l. Well location
 - m. Cistern Pump location, model and type including applicable O&M manual(s).
 - n. Other related equipment as directed by Landscape Architect.
2. Deliver a reproducible Record Drawing to the Landscape Architect within seven

(7) working days before the date of Final Inspection. Delivery of the record drawings shall not relieve the Contractor of the responsibility of furnishing required information in the future.

D. Maintenance Material - Supply the following tools to the Owner;

1. Three (3) sets of specialized tools required for removing, disassembling and adjusting each type of sprinkler, valve or other equipment supplied on this project.
2. Two (2) keys for each type of equipment enclosure.
3. Two (2) keys for each type of automatic controller.
4. Two (2) quick-coupler keys and matching hose swivels for each type of quick coupling valve installed.
5. Two (2) five foot valve keys for operation of gate valves.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Furnish and deliver materials in manufacturer's packaging, bearing and original legible labeling.
- B. Handle and store all equipment/material in accordance with manufacturer's current printed specifications.

1.05 SEQUENCING AND SCHEDULING

- A. Acceptance: Do not install main line trenching prior to acceptance by Design Team/Owner Rep. Landscape Architect of rough grades completed under another Section.
- B. Coordination: Coordinate with the work of other sections to insure the following sequence of events.
 1. Sleeves and Conduits: Installation of all sleeves and conduits to be located under paving and through walls prior to placement of those materials.
 2. Irrigation equipment: All equipment tied to main line, including but not limited to: valves, backflow preventer, quick coupler.
 3. Bubbler Heads in Tree Planter Pockets: Install after placement of tree, but prior to backfill with planter soil mix.
 4. Drip Line: Install after placement of plants, but prior to backfill with planter soil mix.

1.06 WARRANTY: ONE YEAR PERIOD

- A. Contractor to provide a written Warranty on its letterhead for the irrigation system in accordance with the sample warranty form the last page of this specification. File with the Owner or his representative prior to final inspection and acceptance of the irrigation system.

- B. Include a copy of the warranty form in the Operations and Maintenance Manual.
- C. Filling and repairing depressions and replacing plantings due to settlement of irrigation trenches.
- D. Adjusting system to supply proper coverage of areas to receive water.
- E. Ensuring system can be adequately drained.

1.07 MAINTENANCE

- A. Routine: Inspect and adjust all spray heads/rotors and control valves including raising or lowering to accommodate plant growth, to achieve uniform irrigation at all times. Verify correct operating pressure.
- B. Ensure that hose bib valves are in proper working order and are maintained free and clear of debris or obstructions etc.
- C. Controller: Inspect regularly for power interruption and reset clock as required. Adjust station timing to accommodate changes in plant growth.
- D. Irrigation Filter: All of above plus keep strainer clean. Flush as required per manuf. recommended best practice. Inspect operation as recommended by manufacturer.
- E. System Failure: Perform all repairs within one (1) operating period. Replacements to match removed products and materials in all respects. Report promptly all damage not resulting from Contractor's operations. Repair all damage caused by Contractor at no expense to Owner.
- F. Climate Change: Do not run the irrigation system while raining. Set and program automatic controllers in response to seasonal requirements and requirements of newly-planted materials.

PART 2 - PRODUCTS

2.01 GENERAL

- A. Use only new materials of brands and types noted on Drawings or substitutes accepted by Landscape Architect.
- B. Irrigation Pump: Provided and installed by landscape contractor. Coordinate with General Contractor and Mechanical engineer for pump product and specifications.

2.02 PIPE

- A. Pressure Main Line Pipe and Fittings: All PVC fittings shall bear the manufacturer's trademark name, material designation, size, applicable I.P.S. schedule and NSF seal of approval.
 - 1. PVC pressure rated pipe: ASTM D2241 NSF approved Type II, Grade I, PVC. All pipe must meet Federal Specifications pS-22-70, with an appropriate standard dimension ratio (S.D.R.)

- a. Fittings 1 1/2" on the main pressure line shall be Schedule 80 pressure rated PVC.
 2. PVC scheduled pipe: ASTM D1785 NSF approved Type II, Grade I, PVC. All pipe must meet Federal Specifications PS-21-70.
 3. PVC solvent-weld fittings: ASTM D2466 Schedule 40, 1-2, II-I NSF approved.
 4. Solvent cement and primer for PVC solvent-weld pipe and fittings: Type and installation methods prescribed by the manufacturer.
 5. Connections between main lines and RCVs: Schedule 80 PVC (threaded both ends) nipples and fittings.
 6. Galvanized pipe: ASTM A-53 and A120-84, ANSI B1.20.1 and B36.10 Seamless standard weight steel.
 7. Copper pipe: ASTM B 42-84 or as specified by local plumbing code, Type L or K copper water pipe.
- B. PVC Non-Pressure Lateral Line Piping and Sleeving:
1. PVC pressure rated pipe: ASTM D2241 NSF approved Type II Grade I, PVC and Federal Specification PS-22-70, with an appropriate standard dimension ratio (S.D.R.).
 - a. All 1 1/2" fittings and smaller shall be Schedule 80 pressure rated PVC.
 2. PVC scheduled pipe: ASTM D1785 NSF approved Type II Grade I, PVC and Federal Specification PS-21-70.
 3. PVC solvent - weld fittings: ASTM D2466 Schedule 80, 1-2, II-I NSF approved.
 4. Flexible PVC: ASTM D-2287 Algae-resistant flexible PVC.
 5. Polyethylene: ASTM D2237-83, 80 PSI.
 6. Copper: ASTM B-42-84 Type L or K.

2.03 SPRINKLERS

- A. Spray Heads:
1. See Drawings.
- B. Rotor Heads:
1. See Drawings.
 2. All stream rotary and impact heads shall be installed on swing joint assemblies with three Schedule 40 1" street ells and one 1x8 Schedule 80 nipple or pre-assembled swing joint by Spears or Lasco.

2.04 CONTROLLER(S)

- A. Type: See Drawings.

2.05 CONTROL WIRES AND SPLICES (TBD ON FINAL DESIGN OF CONTROLLER)

- A. Type: Copper with UL approval for direct burial, size 14-1. Common ground wire with white insulating jacket; individual control wires with insulating jacket of color other than white.
- B. Splices: DBR/Y by 3M for traditional wire control systems

2.06 REMOTE CONTROL VALVES

- A. Type: See Drawings

2.07 BOXES FOR REMOTE CONTROL VALVES

- A. For softscape areas:
 - 1. Type: Rectangular plastic valve box - Ametek, Brooks, Christy, Rain Bird or accepted equal.
 - 2. Lid: T-Type and Bolt down or lockable
 - 3. Colors:
 - a. Lawn Areas: Green box and lid
 - b. Plant Beds: Brown/Tan box and lid
- B. For hardscape areas:
 - 1. Type: Precast concrete box
 - 2. Lid: Concrete w/ "Irrigation" and/or "Water" label permanently marked for identification.

2.08 ISOLATION VALVES

- A. Ball valves 2-1/2 inches and smaller: Threaded, 2-piece, full port, brass, Blow-out proof stem, operation handle.
- B. Gate valves 3 inches and larger: 125 point WSP, iron body, bronze mounted, non rising stem, solid wedge disc.
- C. Box: 10" round plastic, Ametek, Brooks, Christy, Rainbird or accepted equal.
 - 1. Color: Green in lawn areas and Black in bark mulch areas, Brown in rock mulch areas

2.09 BACKFILL MATERIAL

- A. Backfill soil around lateral and main line pipe shall be of same soil as approved in topsoil specification. In no case shall backfill contain rocks larger than half inch in any direction.

2.10 GRAVEL

- A. For use around drains, valves boxes, valves, and quick couplers
 - 1. Quarter inch (min.) and three-quarter inch (max.) size angular, washed stone.

2.11 VALVE TAGS

- A. Aluminum or plastic tag w/ embedded or raised numbers:
 - 1. Rainbird, Christy, or as approved by Architect before use.

2.12 STOP AND WASTE VALVE

- A. Mueller H - 10288 or approved equal of manual type for operation by handle key.

2.13 MISCELLANEOUS INSTALLATION MATERIALS

- A. Solvent cement and primers for solvent weld joints: Make and type approved by manufacturer(s) of pipe and fittings. Maintain cement proper consistency throughout use.
- B. Pipe joint compound: Permatex 51-D. Do not use on sprinkler inlet port.
- C. Coatings for below grade steel pipe and fittings: Koppers Bitumastic #300-M coal tar epoxy and wrapped with 50-mil polyethylene tape to 6" above finish grade.

2.14 MISCELLANEOUS EQUIPMENT/ACCESSORIES

- A. Sleeves and Conduits: See Drawings.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Sleeves and Conduits: Verify that all installed sleeves and conduits are undisturbed and are free of defects or errors introduced by the work of other Sections.
- B. Water Meter/Water Pressure: Test and verify that installation of irrigation water meter by others has generated level of water pressure specified on Drawings. Report any discrepancies in water pressure to Landscape Architect prior to installation of system.
- C. Mechanical Room: Inspect and verify acceptability of room in building designated to receive automatic controller(s).
- D. Stub-outs: Verify that all stub-outs to be provided under another contract are correctly sized, located and installed as noted on Drawings.

- E. Notification: Submit written notification to Landscape Architect within ten (10) working days of above inspections describing all acceptable and non-acceptable site conditions.

3.02 INSTALLATION

A. Examination:

1. Site Verification of Conditions:

- a. Prior to starting work contractor shall perform pressure test at stub-out on main water line provided for irrigation system, at or nearby fire hydrant. Notify Landscape Architect if pressures are over 110 psi or under 75 psi, failure to notify Landscape Architect of discrepancy may result in contractor to re-install/modify irrigation at no additional cost to owner.

B. Conduits and Sleeves:

1. Coordination:

- a. Sleeves will exist only when installed under another subcontract. Inspect as specified above.
- b. For all other installations, provide conduit and sleeve materials and coordinate installation with other trades.

- 2. Extent: Install conduits and sleeves where control wires and pipes pass under paving or through walls. Extend 12" beyond edges of paving and walls and cap ends until ready for use.

- 3. Pipe and control SCH. 40 wiring and tubing under walks, roads and other hard surfaces shall be installed in PVC sleeves of adequate size. Sleeves shall be installed under all streets and pavement wider than the five feet.

- 4. Sleeves for control wires shall be have minimum conduit size as per chart:

- a. Minimum Conduit Size

- b. 1"
- c. 1 -1/2"
- d. 2"
- e. 2 1/2"
- f. 3"

- 5. Install wire pull box with sweep ells as may be required to route wire to the irrigation controller and maintenance access.

C. Excavating and Trenching:

1. Trenches: Dig trenches wide enough to allow a minimum of 6 inches between parallel pipe lines. Provide a minimum cover from finish grade as follows:
 - a. 12 inches Deep: Control Wire and Flow Sensor Cable not following piping.
 - b. 12-18 inches Deep: Over all lateral pipe.
 - c. 18 inches Deep: All irrigation mainline pipe and PVC sleeves.
 - d. PVC Sleeves & PVC Piping Under Pavement: Provide a minimum of 4 inches of sand backfill on all sides and allow for corresponding cover to bottom of paving per the type of line to be installed in the sleeve (see previous depths).

D. Pipe Line Assembly:

1. General:
 - a. Install pipes and fittings in accordance with manufacturer's current printed Specifications.
 - b. Clean all pipes and fittings of dirt, scales and moisture before assembly.
2. Solvent-Welded Joints for PVC Pipes:
 - a. Solvents: Use solvents and methods specified by pipe manufacturer.
 - b. Curing Period: Minimum of 1 hour before applying any external stress on the piping and at least 24 hours before placing the joint under water pressure.
3. Threaded Joints for Plastic Pipes:
 - a. Tape: Use Teflon tape on threaded PVC fittings.
 - b. Joining: Use strap-type friction wrench only. Do not use metal-jawed wrench.
4. Threaded Joints for Galvanized Steel Pipes:
 - a. General: Use only factory-made nipples.
 - b. Joining Compound: Use pipe joint compound applied to male threads only.
5. Laying of Pipe:
 - a. Bedding On-grade: Remove from trench all rocks or clods over 3/8 inches diameter or less. Bed pipes in at least 2 inches of soil excavated from trench. Where existing material does not meet this requirement, imported material shall be use. Backfill on all sides of piping to provide a uniform

bearing.

- b. Hard Edges: Bed pipes a minimum of 12 inches away from curbs or sidewalks to allow for easy access and maintenance.
- c. Snaking: Snake pipe from side to side of trench bottom to allow for expansion and contraction. Minimum allowance for snaking is one (1) additional foot per 100 ft. of pipe.
- d. Moisture Restrictions: Do not lay PVC pipe when there is water in the trench. Do not assemble PVC pipe unless the pipe is perfectly dry.

E. Isolation Valve:

1. Locate in line and adjacent to control valves when possible and aligned in a row when grouped, and locate in planted areas. Install box flush with finish grade, not necessarily level.
2. Permanently mark valve box lid with "IV", indicating isolation valve. Contractor to submit example of branding prior to performing on installed boxes.

F. Control Valves:

1. Install in valve boxes where shown on Drawings and group together where practical. Install box flush with finish grade, not necessarily level. Avoid locating in high traffic areas.
2. Where two or more valves are installed adjacent to each other, provide at least 6 inches of separation. Align boxes in a row.
3. Permanently mark valve box lid with valve number(s) and controller name as shown on drawings. Contractor to submit example of branding prior to performing on installed boxes for review and approval.
4. Valve boxes shall be at finished grade with valve stems 4 inches below top of box and with 3 inches of pea gravel under the valve. Isolation valves at all valve banks.

G. Stop and Waste Valve: Mueller H - 10288 or approved equal of manual type for operation by handle key.

H. Sprinkler Heads:

1. Coordination: Coordinate installation with planting contractor to insure timely and proper placement of heads at new planting.
2. Spacing: Do not exceed spacing shown on drawings or manufacturer's recommendations.
3. Sprinkler heads next to walks or curbs shall be set 4 inches away from and 2 inches below the top of the walk or curb. The contractor shall set heads at finished grade after the lawn has been established.

I. Automatic Controller:

1. General: Install per local code and manufacturer's current printed Specifications.
2. If valve numbers are not indicated on the drawings connect remote control valves to controller in clockwise sequence to correspond with station setting beginning with Stations 1, 2, 3, etc.
3. Labeling: Affix controller name as labeled on the drawings with (i.e., "CONTROLLER A") on inside of controller cabinet door with minimum of 1" high permanent letters.
4. Irrigation Diagram: Affix a non-fading copy of irrigation diagram to cabinet door below controller name. Irrigation diagram to be sealed between two plastic sheets, 20-mil. minimum thickness. Use a reduced copy of the Record Drawing, for the irrigation diagram clearly showing all valves operated by the controller, station number, valve size, and type of planting irrigated.

J. Control Wiring:

1. General: Install control wires in common trenches with sprinkler mains and laterals wherever possible. Lay to the bottom side of pipe line. Provide looped slack at valves. Snake wires in trench to allow for contraction of wires. Tie wires in bundles at 10 ft. intervals.
2. Extra Length: Provide 30" extra control wire at each remote control valve splice to facilitate the removal of the remote control bonnet to finish grade without cutting wires.
3. Spare: Install one spare wire per controller, unless indicated otherwise on drawings. Wire to be unconnected, spare control wire running from the controller through each intermediate control valve box. Label wire at associated valve box and at opposite ends as "spare wire."
4. Size: Minimum size of wire is to be determined strictly by the manufacturer's current printed specifications for remote control valves, but not smaller than # 14.
5. Detection Wire: Install a bare copper wire #12 or greater on top of the PVC supply line for the purpose of possible future mine detection search as the control wires are being installed on the bottom of the PVC supply line with electrical tape every ten (10) feet.
6. Splicing: Crimp control wire splices at remote control valves. Seal with specified splicing materials. In-line splices will be allowed only on runs exceeding 2500 ft. All splices not at valve shall be made in a rectangular valve box marked "Irrigation wire"
7. All connections to valves and all splices to be water tight.
8. Controller and Conduits: Wiring to be easily identified, clean and organized so that wire may be maintained, trouble shot and freely replaced in conduit from controller

to the direct bury condition.

- K. Mastic and Tape: Install mastic and tape on all below grade metallic piping. Install per manufacturer's current printed specifications extending mastic and tape to 6 inches above finish grade.
- L. Closing of Pipe and Flushing of Lines:
 - 1. Capping: Cap or plug all openings as soon as lines have been installed to prevent entrance of materials that would obstruct the pipe. Leave in place until removal is necessary for completion of installation.
 - 2. Flushing: Thoroughly flush out all water lines to remove debris before installing heads, valves and other hydrants.

3.03 FIELD QUALITY CONTROL

- A. Adjustment of the System:
 - 1. Flush and adjust all sprinkler heads for optimum performance and to prevent overspray onto walks, roadways, and buildings.
 - 2. Set all sprinkler heads perpendicular to finished grades unless otherwise noted on the Drawings.
- B. Testing of Irrigation System:
 - 1. In the presence of the Landscape Architect test all pressure lines under hydrostatic pressure of 125 pounds per square inch, and prove watertight.
 - 2. Sustain pressure in lines for not less than two (2) hours. If leaks develop, repair and repeat test until entire system passes.
 - 3. When the landscape sprinkler system is completed, perform a coverage test in the presence of the Landscape Architect, to determine if the water coverage for planting areas is adequate.
 - 4. Test controllers individually in the presence of the Owner's Representative and the Landscape Architect. Demonstrate that all control valves operate electrically. Provide vehicles and radio equipment as necessary to expedite this process.
 - 5. Demonstrate to Landscape Architect that irrigation scheduling programmed into controller is adequate for plant requirements without causing runoff, and that scheduling capacities of controller are utilized.
 - 6. Test Master Valve and Flow Sensor or Hydrometer for proper function when installed as a part of contract.
- C. Backflow Preventer: Have backflow preventer tested by third party and provide certification that it meets local codes and standards.

3.04 BACKFILL AND COMPACTING

- A. General: After system is operating and required tests and reviews have been made, backfill excavations and trenches with clean soil, free of debris. For rooftop planters, structural foam may be used.
- B. Backfill for All Soil Trenches: Regardless of the type of pipe covered, compact to minimum 95 percent density under pavements, and 85 percent under planted areas.
- C. Backfill at Existing Underground Pipes: Use only backfill material which has been screened to eliminate all materials larger than 3/8 inch when backfilling adjacent to existing underground pipe lines.
- D. Compacting: Compact soil trenches in areas to be planted to 85% compaction. Jetting process may be used in those areas.
- E. Finishing: Dress off all areas to finish grades.

3.05 RESTORE TO EXISTING CONDITIONS

- A. Where trenching is required across existing lawns, uniformly cut strips of sod 6 inches wider than trench. Remove sod in rolls of suitable size for handling and keep moistened until replanted. Replant sod within 7 days after removal, roll and water generously. Replace damaged lawn areas and plants with new to match existing.
- B. Where existing pavements must be cut to install irrigation system, cut smoothly to straight lines 6 inches wider than trench. Compact subgrade to 95% in six (6) inch lifts and then repair or replace pavement cuts with equivalent materials and finishes.

3.06 MAINTENANCE

- A. The entire sprinkler irrigation system shall be under full automatic operation for a period of two (2) days prior to any planting.
- B. The Landscape Architect reserves the right to waive or shorten the operation period.
- C. Contractor shall be responsible for completion, modification, revision and adjustment of the system as necessary to maintain consistent coverage design.

3.07 CLEAN-UP

- A. Clean up as each portion of work progresses. Remove refuse and excess dirt from the site. Paving shall be swept clean or washed down. Repair damages incurred on the work of others and restore to original conditions.

3.08 REVIEWS PRIOR TO ACCEPTANCE

- A. Notify the Landscape Architect in advance for the following reviews, according to the time indicated:
 - 1. Pre-construction conference - 7 days.

- 2. Supply line pressure test and control wire installation - 72 hours.
 - 3. Coverage and controller test - 72 hours.
 - 4. Final review - 7 days
- B. No reviews will commence without record drawings. In the event the Contractor calls for a review without record drawings, without completing previously noted corrections, or without preparing the system for review, he shall be responsible for reimbursing the Landscape Architect at the rate of two and one-half times the normal office hourly rate per hour portal to portal (plus transportation costs) for the inconvenience. No further reviews will be scheduled until this charge has been paid.

3.09 FINAL REVIEW

- A. Operate each system in its entirety for the Landscape Architect at time of final review. Any items deemed not acceptable by the Landscape Architect shall be reworked to the complete satisfaction of the Landscape Architect.
- B. Provide evidence to the Landscape Architect that the Owner has received all accessories and equipment as required before final review can occur.

3.10 WARRANTY FOR IRRIGATION SYSTEM

- A. We hereby warrant that the irrigation system we have furnished and installed is free from defects in materials and workmanship, and the work has been completed in accordance with the Drawings and Specifications, ordinary wear and tear and unusual abuse, or neglect expected. We agree to repair or replace all defects in material or workmanship which may develop during the period of one (1) year from date of acceptance and also to repair or replace any damage resulting from the repairing of such defects at no additional cost to the Owner. We shall make such repairs or replacements within a reasonable time, as determined by the Owner, after receipt of written notice. In the event of our failure to make such repairs or replacements within a reasonable time after receipt of written notice from the Owner, we authorize the Owner to proceed to have said repairs or replacements made at our expense and we will pay the costs and charges therefor upon demand.

3.11 PROJECT:

3.12 LOCATION:

3.13 _ COMPANY LICENSE #

3.14 ADDRESS: _____

- A. _____

3.15 PHONE: (____) _____

3.16 DATE OF FINAL ACCEPTANCE: _____

3.17 NAME _____

3.18 _____ DATE _____

END OF SECTION

SECTION 32 90 00
GENERAL PLANTING REQUIREMENTS

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. A. This work consists of grading and fine grading topsoil, furnishing and installing all plants and planting materials, and furnishing and installing sod and associated work items required for landscaping.
- B. The work generally includes, but is not limited to the following:
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) Requirements.
 - 2. Topsoil amendment and finish grading.
 - 3. Planting operations.
 - a. The search, selection, transportation, protection and planting of nursery plants.
 - b. Plant bed and plant pit preparation including soil supplements.
 - c. Protection, maintenance, guarantee and replacement of all plants and mulched beds.

1.02 EQUIPMENT

- A. Maintain all equipment, tools and machinery while on the project in sufficient quantities and capacity for proper execution of the work.

1.03 RELATED REQUIREMENTS

- A. Section 01 5639 Temporary Tree Protection.
- B. Section 32 9300 Plants
- C. Section 32 8400 Irrigation
- D. Section 39 9113 Topsoil
- E. Section 32 9116 Mulching

1.04 SUBMITTALS

- A. Samples: Submit the following samples for approval before work is started:
 - Organic Mulch 1 cubic foot of each type to be used.
 - Pre-Emergent Herbicide 2.3 kg (5 pounds) of each type to be used.
- B. Certificates of Conformance or Compliance: Before delivery, notarized certificates

attesting that the following materials meet the requirements specified shall be submitted to the Landscape Architect for approval:

1. Plants (Department of Agriculture certification by State Nursery Inspector declaring material to be free from insects and disease).
 2. Fertilizers.
 3. Sulfur.
 4. Sod - certificates.
- C. Manufacturer's Literature and Data: Before delivery, submit to the Landscape Architect for approval.
1. Anti-desiccant.
 2. Pre-emergent herbicide.
 3. Herbicide.
 4. Insecticide.
- D. Soil laboratory testing results and amendment recommendations from the Contractor.
- E. Within 90 days after contract award, submit a complete list of nursery sources for plants.
- F. Submit plans showing temporary storage area for plants and temporary storage area for dry materials.

1.05 DELIVERY AND STORAGE

- A. Delivery:
1. Notify the Landscape Architect of the delivery schedule in advance so the plants may be inspected upon arrival at the job site. Remove unacceptable plants from the job site immediately.
 2. Protect plants during delivery to prevent damage to root balls or desiccation of leaves or rootball. Protect trees during transport by tying in the branches and covering all exposed branches with a breathable covering. Protect trunks so they are not bruised or scraped in any way. Do not bend, bind or tie plants in a manner that damages bark, breaks branches, or destroys the plant's natural shape. Do not drop balled and burlap plants during delivery. Do not prune prior to delivery.
 3. Deliver plants after preparations for planting have been completed and plant immediately. If planting is delayed more than 6 hours after delivery, protect plants as specified herein.
 4. The use of "tree spade" equipment is not permitted.
 5. Deliver fertilizer and sulfur to the site in the original, unopened containers bearing

the manufacturer's guaranteed chemical analysis, name, trade name or trademark, and in conformance to state and federal law. In lieu of containers, fertilizer and sulfur may be furnished in bulk and a certificate indicating the above information shall accompany each delivery.

6. At time of each delivery, furnish two copies of delivery slips showing type of plant or plant materials and quantity delivered.

B. Storage:

1. Keep seed, sulfur, and fertilizer in dry storage away from contaminants. Store plants not installed on the day of arrival at the site as follows:
 - a. Shade and protect plants from the wind when stored outside.
 - b. Heel in bare root plants.
 - c. Protect plants stored on the project from drying out at all times by covering the balls or roots with moist shredded bark, mulching material.
 - d. Keep plants, including those in containers, in a moist condition until planted, by thoroughly watering rootballs as needed or misting foliage with fine mist spray.
 - e. Protect B&B plants with suitable, durable, breathable covers, in transit and continuously at the site in an approved manner. Store plants away from paved areas in approved locations protected from strong winds.
 - f. Do not remove container grown stock from containers until planting time.

C. Handling:

1. Inspection and approval of plants upon delivery will be for quality, size and variety only and will not in any way impair the right of rejection for failure to meet other requirements during planting or at the time of inspection for final acceptance.
2. Care will be taken to avoid damaging plants while they are being moved from the nursery to storage area at the planting site.
3. Move plants marked B&B on plant list with root systems as intact, solid units and with balls of earth firmly wrapped. Plants with cracked, broken or loosely wrapped balls will be cause for rejection. Rootballs where the root flare zone is not in the top third of the rootball will be cause for rejection. Protect plant roots, balls, and tops from sun or drying winds until final planting. If plants are hoisted, secure hoist to ball only.

1.06 PLANTING INSTALLATION SEASONS AND CONDITIONS

- A. No work shall be done when the ground is frozen, too wet, too dry or in an otherwise unsuitable condition for planting.

- B. Plant woody plants (deciduous and evergreen) only when ground temperatures are above 45 degrees F.

1.07 PLANT ESTABLISHMENT PERIOD

- A. The Establishment Period for plants shall begin immediately after installation, with the approval of the Landscape Architect, and continue until final inspection. During the Plant Establishment Period the Contractor shall:
 - 1. Water all plants to maintain an adequate supply of moisture within the root zone. An adequate supply of moisture is the equivalent of 25 mm (1 inch) of absorbed water per week either through natural rainfall or augmented by periodic watering. Apply water at a slow to moderate rate so as not to displace the mulch or flood the plants. Water thoroughly so that roots receive adequate moisture, not just top layer of soil or surrounding backfill.
 - 2. Replace mulch as required. Control insects and disease.
 - 3. In plant beds and saucers, remove grass, weeds, and other undesired vegetation, including their roots, before they reach a height of 75 mm (3 inches).
 - 4. Spray with approved insecticides and fungicides to control pests and ensure plant survival in a healthy growing condition, as directed by the Landscape Architect.
 - 5. Plants to be in a healthy, thriving, growing condition at end of guarantee period.
 - 6. Do not prune plants. Do not paint wounds with any substance.
 - 7. Promptly remove plants that die during this period and replace each plant with one of the same size, species and variety.
 - 8. The Contractor is not responsible for theft or damage to plants by non-contractor vehicles or vandalism once plants are installed and approved.
 - 9. Submit monthly reports to Landscape Architect describing maintenance work performed and proposed work for the following month.

1.08 PLANT GUARANTEE

- A. A one year Plant Guarantee will begin on the date of the final inspection, as outlined in Part 3 PLANT GUARANTEE AND REPLACEMENT.

1.09 APPLICABLE PUBLICATIONS

- A. The publications listed below, form a part of this specification to the extent referenced. The publications are referenced in the text by basic designation only.
- B. American National Standards Institute (ANSI) Publications:
- C. ANSI Z60.1 2014.....Nursery Stock
- D. ANSI Z133.1 2017.....Tree Care Operations Pruning, Trimming,

Repairing Maintaining, and Removing Trees and Cutting Brush Safety Requirements

- E. Hortus Third, A Concise Dictionary of Plants Cultivated in the U.S. and Canada, MacMillan Publishing Co. 1978.
- F. American Society For Testing And Materials (ASTM) Publications:
 - 1. C136 96(Rev. A).....Sieve Analysis of Fine and Coarse Aggregates
 - 2. D977 98.....Emulsified Asphalt (AASHTO M140 1988)
 - 3. D2028 97.....Cutback Asphalt (Rapid curing Type)
- G. S. Department of Agriculture Federal Seed Act of August 9, 1939:
 - 1. 53 Stat. 1275.....Rules and Regulations
- H. Florida Exotic Pest Plant Council (FLEPPC) Invasive Plant Lists

PART 2 - PRODUCTS

2.01 GENERAL

- A. All plant material will conform to the cultivated varieties specified or shown in the plant list and be true to botanical name as listed in Hortus Third.
- B. Plants that do not meet the criteria listed in this section may be rejected by the Landscape Architect and replaced by the Contractor at no additional cost to the Owner.

2.02 PLANTS

- A. Plants shall be in accordance with ANSI Z60.1, except as otherwise stated in the specifications or shown on the plans. Where the drawings or specifications are in conflict with ANSI Z60.1, the drawings and specifications shall prevail. All materials subject to approval of Landscape Architect.
- B. Provide well branched and formed planting stock, sound, vigorous, and free from disease, sunscald, windburn, abrasion, harmful insects or insect eggs with healthy, normal, and unbroken root systems and trunks that are not bruised, scraped, or showing evidence of frost crack. Plants shall have been grown under climatic conditions similar to those in the locality of the project. The supplying nursery shall have sprayed all plants budding into leaf or having soft growth with an anti-desiccant before digging.
 - 1. Provide trees that are single trunked with a single leader, without weak crotches or included bark, unless otherwise indicated. Provide symmetrically developed deciduous trees and shrubs of uniform growth habit, with straight boles or stems and free from objectionable disfigurements, and evergreen trees and shrubs with well-developed symmetrical tops with typical spread of branches for each particular species or variety. Evidence of pruning via the flush cut method (below the branch collar) and/or topping cuts will be cause for rejection.

2. Provide groundcover, perennial, and vine plants with the number and length of runners for the size specified, and the proper age for the grade of plants specified. Provide vines and ground cover plants well established in removable containers.
- C. The minimum acceptable sizes of all plants with branches in normal position shall conform to the measurements designated. Plants larger in size than specified may be used with the approval of the A/E, with no change in the contract price. When larger plants are used, increase the size of root ball or spread of roots in accordance with ANSI Z60.1.
 - D. Provide nursery grown plant material conforming to the requirements and recommendations of ANSI Z60.1. Prepare plants for shipment in a manner that will not cause damage to branches, shape, and future development after planting.
 - E. Balled and burlapped (B&B) plant ball sizes and ratios will conform to ANSI Z60.1, consisting of firm, natural balls of soil wrapped firmly with natural burlap, tied, and covered with a wire basket, with root flare zone in the top third of the root ball. Plants with dry roots or loose or cracked balls will be rejected.
 - F. Container grown plants shall have sufficient root growth to hold the earth intact when removed from containers, but shall not be root bound.
 - G. Do not provide plants in "grow bags".
 - H. Make substitutions only when a plant is not obtainable and the A/E authorizes a Change Order providing for use of the nearest equivalent obtainable size or variety of plant having the same essential characteristics with an equitable adjustment of the contract price.
 - I. Provide plants that are free of severed roots that are 1/2" in diameter or larger for trees or 1/4" in diameter or larger for shrubs. Plants with girdling roots that cannot be corrected without injury to the plant will be rejected.
 - J. The Contractor will inspect rootballs of plants immediately upon receiving them from the nursery. No soil is to be heaped on the top of plant root flares. Root flare zone shall be in the top third of the root ball. Any plants delivered with such heaped soil over the root flare will have the soil removed before planting. If the root ball depth does not satisfy ANSI requirements after soil is removed, the plant will be rejected.

2.03 LABELS

- A. Each plant, or bundle or containers of the same species, variety, and size of plant, shall be legibly tagged with a durable, waterproof and weather-resistant label indicating the correct plant name and size specified in the plant list. Labels shall be securely attached and shall not be removed by the Contractor at any time.

2.04 TOPSOIL (SEE STRUCTURAL SOIL)

- A. Topsoil depths shall be as follows:

2.05 SOIL CONDITIONERS

- A. Leaf compost, composted minimum one year, (leaf mold) that is screened and free of trash.

2.06 PLANTING BED SOIL MIXTURE

- A. Planting bed soil mixture shall be composed of 3 parts by volume of topsoil, and 1 part compost plus fertilizer as recommended by soil tests.

2.07 PLANT FERTILIZER

- A. Provide a complete plant fertilizer that is commercial grade and uniform in composition and conforms to applicable state and federal regulations.
- B. All fertilizer shall be granular with 35% or 80% of the total nitrogen in a slow release form.
- C. Fertilizer shall be added to amended soil and around plants as per the soil test recommendations for growing each plant type.
- D. All fertilizers for seeding shall be uniform in composition, free flowing and suitable for application with approved equipment. Fertilizers shall be delivered to the site fully labeled according to applicable State Fertilizer laws and shall bear the name, trade name or trademark and warranty of the producer. Applications shall be determined by soil test recommendations and approved by the A/E.

2.08 MICORRHIZAL

- A. Plants shall be installed with micorrhizal material, MicoGrow, or approved equal. This aids root development and overall plant health.

2.09 MULCH

- A. Mulch shall be free from deleterious materials and shall be stored as to prevent inclusion of foreign material.
- B. Mulch shall be Pine Bark Nuggets installed to a 3" depth or approved equivalent. Inclusion of twigs, limbs, wood shavings, saw-dust, foreign or toxic substances is prohibited.

2.10 WATER

- A. Water shall not contain elements toxic to plant life. It shall be water obtained from the site irrigation system at no cost to the Contractor.

2.11 ANTI-DESICCANT

- A. Anti-desiccant shall be an emulsion of beta pinene polymer that will provide a clean, colorless, flexible film over plant surfaces permeable enough to permit transpiration in accordance with ASTM F372.23. Product shall be Wiltpruf or approved equal.

2.12 HERBICIDES

- A. All herbicides shall be properly labeled and registered with the U.S. Department of Agriculture. Keep all herbicides in the original labeled containers indicating the analysis and method of use.

2.13 INSECTICIDE/FUNGICIDE

- A. Insecticide product selected by Contractor must be approved by A/E.

2.14 TREE STAKING & TREE STAKING MATERIALS

- A. Tree guying and staking is to be performed per the methods and material as detailed on the Drawings as approved by the A/E. All trees to be set plumb for Final Acceptance.
- B. Stakes - 2" hardwood stakes.
- C. Guying material shall be 3/4" flat woven polypropylene strap with 900 lb. break strength such as Deep Root Arbor Tie (1-800-458-7668) or approved equal, black color.

PART 3 - EXECUTION

3.01 LAYOUT

- A. Stake plant locations and bed outlines on project site for approval by the A/E before any plant pits or beds are dug. The A/E may approve adjustments to plant material locations to meet field conditions.
- B. Examine subgrade, verify elevations and observe conditions under which work is to be performed, and notify A/E of unsatisfactory conditions, such as but not limited to lack of percolation in planting excavations. Do not proceed with work until unsatisfactory conditions have been corrected.

3.02 EXCAVATION FOR PLANTING

- A. Prior to excavating for plant pits and bed, verify the location of any underground utilities. Damage to utility lines will be repaired at the Contractor's expense. Observe precautionary measures to protect all new and existing structures and paving from damage during planting operations.
- B. Remove rocks and other underground obstructions to a depth necessary to permit proper planting according to plans and specifications. Where underground utilities, construction, or solid rock ledges are encountered, the A/E may select other locations for plants.
- C. Do not use an auger for excavation. Size the plant pits and beds as shown on drawings. Mix in soil conditioner to achieve ratio of 50% organic material to 50% native soil. Firm bottom of planting pit so that settling of plants will not occur.
- D. Fill plant pits with water and allow to percolation before planting. Where pits will not drain in 30 minutes or less and will affect the health of the plant, notify the A/E and provide additional under-drains connected to an outfall to provide positive drainage.

3.03 SETTING THE PLANTS

- A. Handle balled and burlapped and container grown plants only by the ball or container. Remove container-grown plants in such a way to prevent damage to plants or root system or splitting the rootball. Set plants plumb, hold in position and backfill and tamp soil up to one-half the height of the roots or ball to support. Allow water to settle. Do not adjust tree

straightness by pulling on the trunk. Trim burlap and wire from top one-half of root ball, leaving the bottom half to remain. Backfill remainder of pit to depth of root flare zone. Set plants in relation to surrounding grade so that base of root flare is even with the surrounding grade. Set rootballs up to two inches higher if wet conditions are encountered as approved by A/E. Use water to settle soil, do not tamp or stomp. Form earth saucers or water basins around plants with topsoil to direct water onto rootball, not backfill. Apply microrrhizal product as per manufacturer's specifications.

- B. Where plants are designated to occur in plant bed areas versus individual locations provide the following preparation. Excavate entire plant bed area to depth of eighteen (18) inches. Backfill excavated area with Planting Bed Soil Mixture as specified herein to a depth of eighteen (18) inches.
- C. For container grown stock; slice, but do not cut through the roots of the rootballs, slice vertically 4 to 5 times, spacing cuts equally along outside perimeter, or loosen roots manually. Prune away all girdling roots.
- D. For balled and burlapped plants, inspect exterior of rootball and provide a clean cut to any roots at the surface of the rootball larger than 1/2 inch.
- E. For groundcovers, perennials and annuals, mulch specified depths prior to planting. Set plants in planting mixture avoiding intrusion of mulch, and lightly tamp soil around each plant to eliminate air pockets; respread mulch to correct depth. Keep mulch away from plant crowns.
- F. Prior to mulching, treat plant saucers, shrub, and planting bed areas with an approved pre-emergent herbicide.

3.04 EDGING PLANT BEDS

- A. Uniformly edge beds using a sharp tool to provide a clear cut division line between the planted area and the adjacent lawn. Include any edging materials (i.e. steel edging, mow-curb etc.) as may be shown in drawings.

3.05 MULCHING PLANTS

- A. Mulching individual trees and shrubs: Spread a three (3) inch depth of top dressing mulch of shredded composted hardwood bark within 48 hours after planting and apply a pre-emergent herbicide.
- B. Mulching tree, shrub and perennial planting beds: Spread a top dressing mulch type and size as shown in plans to a uniform minimum thickness three (3) inches settled depth measured one week after placement. Keep mulch one inch away from tree trunks. Cover entire bed with the mulch top dressing unless otherwise shown/specified in drawings.
- C. Keep mulch out of the crowns of shrubs and perennials and off buildings, sidewalks, light standards, and other structures.

3.06 PRUNING

- A. Contractor shall not prune any plant before, during, or after installation. All pruning will

be performed by certified arborist under the direction of the A/E.

3.07 PLANTING AREAS SUBGRADE PREPARATION

- A. Refer to Specification Section SPREADING TOPSOIL.

3.08 FINISH GRADING

- A. Do not handle or work topsoil when frozen or excessively wet or dry. After bulk topsoil has been spread as specified, fine grade with approved equipment. Produce smooth uniform surfaces to finish grades shown on the drawings. Correct irregularities in finished topsoil surfaces to eliminate depressions. All debris and stones larger than 1" remaining on the surface after fine grading will be removed. Use Harley rock rake for stone removal. Protect finished topsoil areas from damage by vehicular or pedestrian traffic. Complete lawn work only after areas are brought to finished grade.

3.09 MAINTENANCE OF PLANTS

- A. Contractor will maintain all plants within the limits of the work in accordance with these specifications until final inspection by the Owner.
- B. During actual planting process, and for a period of 12 months after final acceptance of completion of plant installation (the Maintenance Period), maintain plants and work incidental thereto by replanting, watering, fertilizing, weeding, cultivating, re-mulching, controlling insects and disease, and by performing all other operations of care for promotion of root growth and plant life so that all work is in the satisfactory condition at the completion of the contract and throughout the maintenance period.
- C. During the maintenance period, replace planted trees and shrubs that have died, or are in an unhealthy, unsightly, or badly impaired condition. Remove dead plants as soon as the condition is evident. Replace with healthy plants as soon as is reasonably possible. Do not make replacements in any season unfavorable for planting.
- D. At the conclusion of the maintenance period, an inspection of the work will be made to determine the condition of all plants. Plants at that time that are not in healthy growing condition will be noted. Remove plants noted to be unhealthy, unsightly, or damaged from the site immediately and replace as soon as seasonal conditions permit with healthy plants of the same kinds and sizes as originally specified. Make such replacements in the same manner as specified for the original planting, and at no additional cost to the Owner.
- E. The Contractor will not be held responsible or liable for damages to plants and planting materials by animals, malicious or careless damage by human individuals or agencies over which he has no control, or fire or snow and ice after plants are installed.
- F. Maintenance Procedures:
 - 1. Watering: Thoroughly water trees and shrubs every two weeks. In extremely dry periods, additional watering may be required; in abnormally wet periods, the watering may be modified as approved. Check relative moisture content of soil for typical tree and typical shrub planting each two weeks, and weekly during warm and/or dry months. Use Peerless Moisture Indicator, Tree Type, or equal

following manufacturer's recommendations. Provide sufficient water to maintain relative moisture content of 25 to 30 percent.

2. Weeding: During the growing season, weed the mulched area around each plant twice a month. Chemical weed killers may be used, subject to approval, but at the responsibility of the Contractor. Remove weeds from site.
3. Spraying: Treat plants with an approved chemical spray or absorbent chemical as required to treat for insect, disease, and fungus growth that will weaken or deform the plant. Have treatment approved and assume full responsibility for effectiveness of the treatment and plant survival. For all spray products, including fertilizers, pesticide, and anti-desiccants, protect abutting cars, pedestrians, structures, site improvements, and construction from damage or staining from product application and drifting spray.

3.10 PLANT GUARANTEE AND REPLACEMENT

- A. The Contractor shall have completed, located, and installed all plants according to the plans and specifications. All plants are expected to be living and in a healthy condition at the time of final inspection.
- B. Plants will be guaranteed for one year after certification to and approval by the Landscape Architect for completion of plant installation, against death and unsatisfactory growth, except for damage resulting from neglect by the Owner, abuse or damage by them, or unusual phenomena or incidents beyond the Contractor's control as approved by the Landscape Architect. The Contractor further guarantees that all plants will be in a healthy, growing condition at the end of the guarantee period.
 1. Guarantee for plants is limited to one replacement during the guarantee period.
 2. Contractor will maintain a written log of all plant material that has died, including location, date plant was determined to be dead, date of removal, and date of replacement. Logs will be submitted to the Landscape Architect for his approval prior to acceptance of replaced plants. Replaced plants will not be accepted without the written log.
 3. Any plant required under this contract that is dead or not growing satisfactorily, as determined by the Landscape Architect, will be removed immediately and will be replaced during the appropriate planting season as specified herein. A one year guarantee for the plants replaced will begin on the day the work is completed.
 4. All replacements will be plants of the same kind and size as originally specified. They will be furnished and planted as specified herein; the cost will be borne by the Contractor except for replacements resulting from removal, loss or damage due to occupancy of the project in any part, vandalism, or act of neglect on the part of others.
 5. Replacement of plants transplanted on site (that the Contractor did not supply) is not required unless they die from improper handling and care during transplanting. Loss through Contractor negligence requires replacement in kind and size.

- C. The Owner will inspect all plants at the end of the One Year Guarantee. The Contractor will replace any dead, missing, or defective plants immediately. If plants cannot be replaced immediately, the Contractor will notify the Landscape Architect prior to the final inspection. The Guarantee will end on the date of this inspection provided the Contractor has complied with the work required by this specification. The Contractor shall also comply with the following requirements:
1. Replace dead, missing or defective plant material prior to final One Year Guarantee inspection.
 2. Mulch and weed plant beds and saucers. Just prior to this inspection, treat these areas to a second application of approved pre-emergent herbicide.
 3. Remove stakes, staking materials and any required tree wrappings from trees that have been installed for one year.
 4. Complete remedial measures directed by the Landscape Architect to ensure plant survival.
 5. Repair damage caused while making plant replacements.

3.11 RESTORATION AND CLEAN UP

- A. Where existing or new planting areas have been damaged or scarred during planting and construction operations, restore disturbed area to their original condition. In areas where planting work has been completed, clear the area of all debris, spoil piles, and containers. Clear all other paved areas when work in adjacent areas is completed. Remove all debris, rubbish and excess material from the site.

3.12 FINAL REVIEW

- A. The Landscape Architect, upon written request of the Contractor submitted at least 10 days prior to the anticipated inspection date, will inspect the work to determine its completion. The condition of the work will be noted and a determination made regarding any continued maintenance.
- B. After inspection, the Contractor will be notified in writing by the Landscape Architect of acceptance of work, subject to guarantee or, if there are any deficiencies, of the requirements for completion of the work. All work remaining to be done will be subject to subsequent inspection before Acceptance.

END OF SECTION

SECTION 32 9113
SOIL PREPARATION

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Furnish all labor, materials, equipment, tools and services required to fully complete all Soil Prep work as is indicated on the drawings and/or specified herein including, but not limited to, the following described items.
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) Requirements.
 - 2. Perform soil preparation work as described in Contract Documents.
 - 3. Furnish and apply soil additives as described in Contract Documents.

1.02 SUBMITTALS

- A. Product Data: Product literature and chemical / nutrient analysis of soil amendments and fertilizers.
- B. Samples: Sample of soil conditioner and topsoil for approval before delivery to site. Include product analysis list and topsoil test report.
- C. Quality Assurance / Control: Delivery slips indicating amount of soil conditioner delivered to Project site.

1.03 QUALITY ASSURANCE

- A. Pre-Installation Conference: Participate in pre-installation conference specified in Section 31 2213.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Incorporate following soil amendments into topsoil from site used for Project:
 - 1. Acceptable Soil Amendments, Soil Conditioners, and Application Rates
 - a. Add fertilizers at application rates as recommended from Topsoil Testing Report.
 - 2. Acceptable Fertilizers And Application Rates:
 - a. Add fertilizers at application rates as recommended from Topsoil Testing Report.
 - b. Equal as approved by Architect before installation.

PART 3 - EXECUTION

3.01 PERFORMANCE

- A. Add specified soil amendments at specified rates to lawn areas. Roto-till or otherwise mix amendments evenly into top 4 inches of topsoil. Incorporate and leach soil amendments which require leaching, such as gypsum, within such time limits that soil is sufficiently dry to allow proper application of fertilizer and soil conditioners.

END OF SECTION

SECTION 32 9116
MULCHING

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Furnish all labor, materials, equipment, tools and services required to fully complete all Mulch work as is indicated on the drawings and/or specified herein including, but not limited to, the following described items.
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) Requirements.
 - 2. The work to be performed shall consist of furnishing and placing mulch, including site preparation, edging, and weed control fabric.

1.02 RELATED REQUIREMENTS

- A. Section 32 9300: Plants
- B. Section 31 2216: Fine Grading

1.03 QUALITY ASSURANCE

- A. Any deviation from the contract documents shall have written approval of owner and Landscape Architecture

1.04 SUBMITTALS

- A. Product Data: Contractor shall furnish a 2 kg sample of mulch to Landscape Architect for approval prior to delivery of materials to the site and prior to placing.

PART 2 - PRODUCTS

2.01 MULCH: BARK MULCH

- A. Fine Bark Mulch (Shrub Beds): Shredded fine bark mulch or pine bark chips product, natural color (earth tones). Place as a top dressing mulch at 3” depth. Provide samples for approval.
- B. Soil Pep (Annual & Perennial Beds): Soil Pep soil conditioner product. Place as a top dressing mulch at 3” depth. Provide samples for approval.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Before proceeding with work, check and verify dimensions and quantities. Report variations between Drawings and site to Landscape Architect before proceeding with work of this Section.

3.02 PREPARATION

- A. Clear trash, debris and vegetation from areas to receive mulch.
- B. Excavate to the depth shown on drawings, grade to a smooth surface, and compact to minimum 90% relative compaction. Soil surface shall be smooth, firm stable and free of rocks, clods, foliage, roots or other material greater than one inch in diameter. Earthwork shall conform to the provisions in section 32 9120.
- C. Treat sub base with pre-emergent herbicide.

3.03 PLACEMENT

- A. Place mulch as a single layer to depth shown on Drawings.
- B. Finished elevation of the mulch shall be equal to adjacent finish grade. Acceptable tolerance is 1/2 inch difference for mulch.
- C. Final surface shall be uniform and maintain original flow lines, slope gradient and contours of the project site.

END OF SECTION

SECTION 32 91 19
TOPSOIL PLACEMENT AND GRADING

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Furnish all labor, materials, equipment, tools and services required to fully complete all Topsoil work as is indicated on the drawings and/or specified herein including, but not limited to, the following described items.
 - 1. Refer to “PART 2 – PRODUCTS” for all Buy America Build America Act (BABA) Requirements.
 - 2. Perform topsoil placement and grading work required to prepare site for installation of landscaping as described in Contract Documents.
 - 3. Furnish and apply soil additives as described in Contract Documents.
 - 4. Furnishing of topsoil for cast-in-place planters as described in Contract Documents.

1.02 SUBMITTALS

- A. Product Data: Product literature and chemical / nutrient analysis of soil amendments and fertilizers.
- B. Samples:
 - 1. Sample of soil conditioners and amendments for approval before delivery to site. Include product analysis list.
 - 2. Sample of topsoil with accompanying topsoil test report.
- C. Quality Assurance / Control:
 - 1. Submit test on topsoil by licensed laboratory before use, using Owner Form ‘Topsoil Test Report.’
 - a. Before use, existing or imported topsoil shall meet minimum specified requirements and be approved by Architect.
 - b. If necessary, submit proposed amendments and application rates necessary to bring topsoil up to minimum specified requirements.
 - 2. Submit report stating location of source of imported topsoil and account of recent use.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Topsoil:

1. Topsoil used in landscaped areas, whether imported or from site, shall be fertile, loose, friable soil meeting following criteria:
2. Clean and free from toxic minerals and chemicals, noxious weeds, rocks larger than 1-1/2 inch in any dimension, and other objectionable materials.
3. Soil shall not contain more than 2 percent by volume of rocks measuring over 3/32 inch in largest size.
4. *Contractor to coordinate and verify appropriate soil physical characteristics. Report any recommended soil profile changes to Landscape Architect prior to purchase and installation of topsoil material.
5. 5) Contractor to coordinate and provide soil sample testing prior to installation of topsoil.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Do not commence work of this Section until grading tolerances specified in Fine Grading Section 31 2216 are met.

3.02 PREPARATION

- A. Protection: Protect utilities and site elements from damage.

B. Subsoil Preparation and Topsoil Placement:

1. Remove all foreign debris from planter areas, including concrete, asphalt, wood, branches, large rocks and other construction debris.
2. Rip, disk, or till top 6 inches of existing subsoil to break up surface and eliminate impervious soil.
3. Verify subsoil grades. Correct high and low areas to proper grade as required.
4. Amend topsoil per recommendations received from topsoil testing prior to spreading.
5. Install topsoil to depth specified.

C. Surface Preparation:

1. Seven days maximum before beginning planting:
 - a. Loosen area 4 inches deep, dampen thoroughly to 6 inches deep, and cultivate to properly break up clods and lumps.

- b. Rake area to remove clods, rocks, weeds, roots, and debris.
 - c. Grade and shape landscape area to bring surface to true uniform planes free from irregularities and to provide drainage and proper slope to catch basins.
2. Limit use of heavy equipment to areas no closer than 4 feet from building or other permanent structures. Use hand guided tillers for preparation of areas closer than 4 feet.

3.03 PERFORMANCE

A. Site Tolerances:

1. Total Topsoil Depth:

- a. Lawn And Groundcover Planting Areas: 6 inches minimum.
- b. Shrub Planting Areas: 18 inches minimum throughout entire shrub bed area.

2. Finish grade of planting areas before planting and after addition of soil additives shall be specified distances below top of adjacent pavement of any kind:

- a. Sodded Areas: 2 inches below.
- b. Shrub and Ground Cover Areas: 4 inches below.

B. Do not expose or damage existing shrub or tree roots.

C. Redistribute approved existing topsoil stored on site as a result of work of Section 31 1413. Remove organic material, rocks and clods greater than 1-1/2 inch in any dimension, and other objectionable materials. Provide additional approved imported topsoil required to bring surface to specified elevation relative to concrete site elements.

D. Where topsoil depth is 12 inches or greater, place topsoil in layers not to exceed 12 inches and, to prevent settling, compact to 85 percent relative density in accordance with ASTM D 1557.

E. Do not place topsoil whose moisture content makes it prone to compaction during placement process.

F. Slope grade away from building for 12 feet minimum from walls at slope of 1/2 inch in 12 inches minimum unless otherwise noted. High point of finish grade at building foundation shall be 6 inches minimum below finish floor level. Direct surface drainage in manner indicated on Drawings by molding surface to facilitate natural run-off of water. Fill low spots and pockets with topsoil and grade to drain properly.

G. After landscape areas have been prepared, take no heavy objects over them. Immediately before planting lawn and with topsoil in semi-dry condition, roll areas that are to receive lawn in two directions at approximately right angles with water ballast roller weighing 100 to 300 lbs depending on soil type. Rake or scarify and cut or fill irregularities that develop

as required until area is true and uniform, free from lumps, depressions, and irregularities.

END OF SECTION

SECTION 32 92 23
SODDING

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Furnish all labor, materials, equipment, tools and services required to fully complete all Topsoil work as is indicated on the drawings and/or specified herein including, but not limited to, the following described items.
 - 1. Refer to "PART 2 – PRODUCTS" for all Buy America Build America Act (BABA) Requirements.
 - 2. Furnish and install sodded lawn as described in Contract Documents.

1.02 RELATED REQUIREMENTS

- A. Section 32 9300: Plants

1.03 SUBMITTALS

- A. Quality Assurance / Control:
 - 1. Written certification confirming lawn seed quality and mix.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Harvest, deliver, store, and handle sod in accordance with requirements of 'American Sod Producers (ASPA) Specifications for Turfgrass Sod Materials and Transplanting / Installing.'
- B. Schedule deliveries to coincide with topsoil operations and laying. Keep storage at job site to minimum without causing delays.
 - 1. Deliver, unload, and store sod on pallets within 24 hours of being lifted.
 - 2. Do not deliver small, irregular or broken pieces of sod.
- C. Handle sod to prevent tearing during lifting and handling. During dry weather, protect sod from drying before installation. Water as necessary to insure vitality and to prevent excess loss of soil in handling. Sod that dries out before installation will be rejected.

1.05 SEQUENCING

- A. Do not commence work of this Section until work of Sections 32 9113 and 32 9300 has been completed and approved.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Certified Sod:

1. Superior sod grown from certified, high quality, seed of known origin or from plantings of certified grass seedlings or stolons:
 - a. Assure satisfactory genetic identity and purity.
 - b. Assure over-all high quality and freedom from noxious weeds or an excessive amount of other crop and weedy plants at time of harvest.
2. Cut and lift sod by method acceptable to Landscape Architect. Cut sod in pieces approximately 3/4 to one inch thick. Roll or fold sod so it may be lifted and handled without breaking or tearing and without loss of soil.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Site Tolerances: Final grade of soil after sodding of lawn areas is complete shall be two inches below top of adjacent pavement of any kind.

B. Laying of Sod:

1. Lay sod during growing season and within 48 hours of being lifted.
2. Lay sod while top 6 inches of soil is moist, but not muddy. Sodding during freezing temperatures or over frozen soil is not acceptable.
3. Lay sod in rows perpendicular to slope with joints staggered. Butt sections closely without overlapping or leaving gaps between sections. Cut out irregular or thin sections with a sharp knife
4. Lay sod flush with adjoining existing sodded surfaces.
5. Do not place small sod pieces less than 6" wide adjacent to edges. Place full piece next to edge and infill as needed.
6. Stagger sod joints on slopes to prevent erosion.
7. Do not sod slopes steeper than 3:1. Consult with Architect for alternate treatment.

C. After Sodding Is Complete:

1. Roll horizontal surface areas in two directions perpendicular to each other.
2. Repair and re-roll areas with depressions, lumps, or other irregularities. Heavy rolling to correct irregularities in grade will not be permitted.
3. Water sodded areas immediately after laying sod to obtain moisture penetration into top 6 inches of topsoil.

3.02 FIELD QUALITY CONTROL

A. Inspection:

1. Sodded areas will be accepted at final inspection if:
 - a. Sodded areas are properly established.
 - b. Sod is free of bare and dead spots and is without weeds.
 - c. No surface soil is visible when grass has been cut to height of 2 inches.
 - d. Sodded areas have been mowed a minimum of twice over a two week period.

B. Maintenance

1. Water and mow sod regularly or as needed until substantial completion

END OF SECTION

SECTION 32 93 00
PLANTS

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Furnish all labor, materials, equipment, tools and services required to fully complete all Planting work as indicated on the drawings and/or specified herein including, but not limited to, the following described items.
 - 1. Refer to "PART 2 – PRODUCTS" for all Buy America Build America Act (BABA) Requirements.
 - 2. Furnish and install landscaping plants as described in Contract Documents.

1.02 RELATED REQUIREMENTS

- A. Section 32 9119: Topsoil Placement and Grading.

1.03 SUBMITTALS

- A. Samples: Top dressing mulch for approval before delivery to site.
- B. Photos: Provide photos of plant materials with scale reference for approval prior to purchase and installation.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Deliver healthy and vigorous trees and shrubs.
 - 1. Do not prune before delivery.
 - 2. Protect bark, branches, and root systems from sun scald, drying, whipping, and other handling and tying damage.
 - 3. Plants with broken rootballs are not acceptable.
 - 4. Do not bend or bind-tie trees or shrubs in such a manner as to destroy natural shape.
 - 5. Provide protective covering during delivery.
- B. Handle balled stock by root ball or container. Do not drop trees and shrubs during delivery.
- C. Deliver trees, shrubs, ground covers, and plants after preparations for planting have been completed and install immediately.
 - 1. If planting is delayed more than six hours after delivery, set planting materials in shade and protect from weather and mechanical damage.
 - 2. Set balled stock on ground and cover ball with soil, saw dust, or other acceptable

material approved by Architect. Do not place on pavement.

3. Do not remove container-grown stock from containers before time of planting.
4. Water root systems of trees and shrubs stored on site with fine spray. Water as often as necessary to maintain root systems in moist condition. Do not allow plant foliage to dry out.

1.05 SEQUENCING

- A. Do not commence work of this Section until work of Section 32 9113 has been completed and approved.

1.06 WARRANTY

- A. Provide written warranties confirming following:
 1. Furnished shrubs, ground covers, and vines guaranteed to live and remain in strong, vigorous, and healthy condition for one year minimum from date landscape installation is accepted as complete.
 2. Trees guaranteed to live and remain in strong, vigorous, and healthy condition for one year from date landscape installation is accepted as complete.

1.07 WARRANTY PERIOD MAINTENANCE PLAN

- A. Provide instructions for Owner's maintenance personnel to contact the installing contractor immediately should there be any warranty issues (such as unhealthy plants or irrigation issues) or other items of concern that fall under the installing contractor's warranty - all warranty items are the installing contractor's responsibility during the maintenance period.
- B. Plan shall include the following items:
 1. Contact Information
 2. Irrigation - Hose Watering (Hose Bib/Quick Coupler)
 - a. Schedule (Adjusted as needed for seasonal changes and for plant establishment schedules)
 - b. Start-up Instructions
 3. Fertilization Instructions:
 - a. Type
 - b. Quantity
 - c. Schedule
 4. Pest/Disease Control

5. Lawn Care
 - a. Mow Height
 - b. Mow Frequency
6. Tree/Shrub Pruning
 - a. Schedule/Timing
 - b. Method of Pruning
 - c. Pruning Type
 - (1) Formal
 - (2) Informal
7. Other items as deemed necessary for the project.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Plants:

1. Conform to requirements of Plant List and Key on Drawings and to ANSI Z60.1.
2. Nomenclature: Plant names used in Plant List conform to 'Standardized Plant Names' by American Joint Committee on Horticultural Nomenclature except in cases not covered. In these instances, follow custom of local nursery trade. Plants shall bear a tag showing the genus, species, and variety of at least 10 percent of each species delivered to site.
3. Quality:
 - a. Plants shall be sound, healthy, vigorous, free from plant disease, insect pests or their eggs, noxious weeds, and have healthy, normal root systems. Container stock shall be well established and free of root-bound conditions.
 - b. Do not prune plants or top trees prior to delivery.
 - c. Plant materials shall be subject to approval by Architect as to size, health, quality, and character.
 - d. Bare root trees are not acceptable.
 - e. Provide plant materials from licensed nursery or grower. All products/plants listed must be verified as locally available. Minimize/avoid importing. Where no exact match is available contractor to present substitution options.

4. Measurements:

- a. Measure height and spread of specimen plant materials with branches in their normal position as indicated on Drawings or Plant List.
- b. Measurement should be average of plant, not greatest diameter. For example, plant measuring 15 inches in widest direction and 9 inches in narrowest would be classified as 12 inch stock.
- c. Plants properly trimmed and transplanted should measure same in every direction.
- d. Measure caliper of trees 6 inches above surface of ground.
- e. Where caliper or other dimensions of plant materials are omitted from Plant List, plant materials shall be normal stock for type listed.
- f. Plant materials larger than those specified may be supplied, with prior written approval of Architect, and:
 - (1) If complying with Contract Document requirements in all other respects.
 - (2) If at no additional cost to Owner.
 - (3) If sizes of roots or balls are increased proportionately.

5. Shape and Form:

- a. Plant materials shall be symmetrical or typical for variety and species and conform to measurements specified in Plant List.
- b. Well grown material will generally have height equal to or greater than spread. However, spread shall not be less than 2/3 of height.

B. Planting Mix: Mixture of three parts good topsoil and one part well-rotted composted manure, or approved commercial mix.

C. Planting Tablets: 21 gram Agriform 20 10 5. (Or Equal as approved by Architect before installation.)

D. Tree Stakes:

1. Type Two Acceptable Products:

- a. 2 inch diameter wooden stakes (submit photo for approval)
- b. Equal as approved by Architect before installation. See Section 01 6200.

E. Tree Staking Ties:

- a. Refer to planting details

F. Pre Emergent Herbicide:

1. Category Four Approved Products. See Section 01 6200 for definitions of Categories.
 - a. Chipco Dimension Granular by The Andersons Inc, Maumee, IL www.andersonsinc.com.
 - b. Elanco XL2G granular by Crop Data Management Systems, Marysville, CA www.cdms.net.
 - c. Ronstar G granular by Bayer CropScience, Monheim, Germany www.bayercropscience.com.
 - d. Surflan AS liquid by United Phosphorous Inc, Trenton, NJ www.upi-usa.com.
 - e. Oryzalin 4 A.S. liquid by FarmSaver, Seattle, WA

G. Bark Mulch: Provide Pine Bark Mulch free of weeds and invasive species at 3" depth in all plant beds. Provide photos/sample for review and approval.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Before proceeding with work, check and verify dimensions and quantities. Report variations between Drawings and site to Architect before proceeding with work of this Section.
- B. Plant totals are for convenience only and are not guaranteed. Verify amounts shown on Drawings. All planting indicated on Drawings is required unless indicated otherwise.

3.02 PREPARATION

- A. Layout individual tree and shrub locations and areas for multiple plantings. Stake locations and outline areas. Secure Architect's acceptance before planting. Make minor adjustments as may be requested.

3.03 INSTALLATION

- A. Excavation:
 1. If underground construction work or obstructions are encountered in excavation of planting holes, Architect will select alternate locations.
 2. Plant Excavation Size:
 - a. Diameter: Twice diameter of root ball or container, minimum.
 - b. Depth: Per Plan Details

3. Unless excavated material meets topsoil requirements, remove from landscape areas and do not use for landscaping purposes.
4. Roughen sides and bottoms of excavations.
5. Water Percolation Test:
 - a. Before planting, select five typical planting excavations throughout the site. Fill each hole with water and verify that water drains away at a rate of 3 inches per hour or greater. Inform Architect in writing if water does not drain properly. Do not plant trees or shrubs in holes that do not properly drain.
 - b. For plant pits that do not drain properly auger 6 inch diameter hole 4 feet deep in low point of each excavation and fill with tamped planting mix

B. Planting:

1. Removing Binders And Containers:
 - a. Remove top one / third of wire basket and burlap binders.
 - b. Remove plastic and twine binders from around root ball and tree trunk.
 - c. Remove wood boxes from around root ball. Remove box bottoms before positioning plant in hole. After plant is partially planted, remove remainder of box without injuring root ball.
2. Plant immediately after removing binding material and containers. Place trees and shrubs in holes so, after watering and settling, top of root ball shall be approximately two inches higher than finished grade and trunk flare is visible for trees. Rootball for shrubs shall be approximately one inch higher than finished grade.
3. Properly cut off broken or frayed roots.
4. Center plant in hole and backfill with specified planting mix. Except in heavy clay soils, make ring of mounded soil around the hole perimeter to form watering basin.
5. Add plant fertilizer tablets in plant pit as follows. Place tablets in relation to root ball as recommended by Manufacturer.
 - a. One Gallon Shrub: 1 tablet.
 - b. 5 Gallon Shrub / Tree: 3 tablets.
 - c. 15 Gallon Tree: 4 tablets.
 - d. 24-inch Box Tree: 6 Tablets.
6. Fill landscape excavations tamped planting mix. Settle by firming and watering to ensure top of ball one inch higher than surrounding soil.

7. Do not use muddy soil for backfilling.
8. Make adjustments in positions of plants as directed by Architect.
9. Thoroughly water trees and shrubs immediately after planting.
10. At base of each tree, leave 36-inch diameter circle free of any grass.
11. Drawings and specifications to guide plant installation wherever possible/appropriate. Follow local installation practices when/where deemed appropriate. Any changes to installation as shown in the details and outlined in spec's to be approved by Landscape Architect/Owner Representative prior to implementation.

C. Supports for New Trees:

1. Provide new supports for trees noted on Drawings to be staked.
 - a. Remove nursery stakes delivered with and attached to trees.
 - b. Support shall consist of at least two tree stakes driven into hole base before backfill so roots are not damaged. Place stakes vertically and run parallel to tree trunk.
 - c. Remove tops of tree stakes so top of stake is 6 inches below main tree canopy to prevent damage to tree branches and canopy growth.
2. Provide guying kits to support 3-inch caliper or 36 inch box and larger trees.

D. Ground Covers: Container-grown unless otherwise specified on Drawings. Space evenly to produce a uniform effect, staggered in rows and intervals shown.

E. Post Planting Weed Control:

1. Apply specified pre-emergent herbicide to shrub and ground cover planting areas and grass-free areas at tree bases after completion of planting.
2. Areas shall be free of existing weed growth prior to application of herbicide.

END OF SECTION

SECTION 34 41 33
TRAFFIC SIGNALS

PART 1 - GENERAL

1.01 SUMMARY

- A. Provide and install Enhanced Warning Sign Assembly as specified by plans and Florida Department of Transportation, FY2025-26 Standard Specifications for Road and Bridge Construction:
1. Section 603 General Requirements for Traffic Control Signals and Devices
 2. Section 608 Manufacturers' Warranties for Traffic Control Signals and Devices
 3. Section 611 Acceptance Procedures for Traffic Control Signals, Devices, and Intelligent Transportation System Devices
 4. Section 620 Grounding and Lightning Protection
 5. Section 630 Conduit
 6. Section 632 Signal Cable
 7. Section 635 Pull Boxes, Splice Boxes, Junction Boxes, and Fiber Optic Splice Vaults
 8. Section 646 Aluminum Poles, Pedestals, and Posts
 9. Section 660 Vehicle Detection System
 10. Section 663 Signal Priority and Preemption Systems
 11. Section 700 Highway Signing

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00:
1. Refer to "PART 2 – Products" for all Buy America Build America Act (BABA) Requirements

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Must meet FDOT FY2025-26 Standard Specifications for Road and Bridge Construction:
1. Section 603 General Requirements for Traffic Control Signals and Devices
 2. Section 608 Manufacturers' Warranties for Traffic Control Signals and Devices

3. Section 611 Acceptance Procedures for Traffic Control Signals, Devices, and Intelligent Transportation System Devices
4. Section 620 Grounding and Lightning Protection
5. Section 630 Conduit
6. Section 632 Signal Cable
7. Section 635 Pull Boxes, Splice Boxes, Junction Boxes, and Fiber Optic Splice Vaults
8. Section 646 Aluminum Poles, Pedestals, and Posts
9. Section 660 Vehicle Detection System
10. Section 663 Signal Priority and Preemption Systems
11. Section 700 Highway Signing

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install according to plans and FDOT FY2025-26 Standard Specifications for Road and Bridge Construction:
 1. Section 603 General Requirements for Traffic Control Signals and Devices
 2. Section 608 Manufacturers' Warranties for Traffic Control Signals and Devices
 3. Section 611 Acceptance Procedures for Traffic Control Signals, Devices, and Intelligent Transportation System Devices
 4. Section 620 Grounding and Lightning Protection
 5. Section 630 Conduit
 6. Section 632 Signal Cable
 7. Section 635 Pull Boxes, Splice Boxes, Junction Boxes, and Fiber Optic Splice Vaults
 8. Section 646 Aluminum Poles, Pedestals, and Posts
 9. Section 660 Vehicle Detection System
 10. Section 663 Signal Priority and Preemption Systems
 11. Section 700 Highway Signing

END OF SECTION 34 41 33

SECTION 40 62 13
SERVER COMPUTERS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Database servers and application servers for Escambia County's advanced traffic management system (ATMS).

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00:
 - 1. Refer to "PART 2 – Products" for all Buy America Build America Act (BABA) Requirements

1.03 SUBMITTALS

- A. Product Data: Provide manufacturer's technical data and installation instructions.
- B. Certifications: Submit evidence of compliance with applicable standards.
- C. Warranty Documentation.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in manufacturer's original, unopened packaging.
- B. Store in a clean, dry location, free from direct sunlight and moisture.

1.05 WARRANTY

- A. Provide standard manufacturer's warranty.

1.06 COORDINATION AND PAYMENT REQUIREMENTS

- A. The Contractor shall coordinate with and pay Escambia County's Central Management Software (CMS) Vendor, Transportation Control Systems, and the Manufacturer, SWARCO McCain, for all necessary services to configure the new RTMC servers and master switches.
- B. The Contractor shall ensure that the servers and switches are properly set up with the CMS and networked to restore the original functionality of Escambia County's ATMS.
- C. Final system acceptance is contingent upon the verification of successful CMS integration, network configuration, and restoration of ATMS functionality.

PART 2 - PRODUCTS

2.01 DATABASE SERVERS

- A. Acceptable Manufacturer: Dell or approved equivalent.
- B. Performance Requirements:
 - 1. Processor: Minimum 2.8 GHz Xeon Multi-Core Processor (Intel).
 - 2. RAM: 16 GB minimum.
 - 3. Storage: 900 GB SSD.
 - a. Drives configured RAID 0/1
 - 4. Operating System: Windows Server 2022.
 - 5. Database Management: SQL Server Standard 2022 with latest SSMS installed.
- C. Additional Requirements:
 - 1. Scalability to support increased data storage for large environments.
 - 2. System designed for continuous operation and data integrity.

2.02 APPLICATION SERVERS

- A. Acceptable Manufacturer: Dell or approved equivalent.
- B. Performance Requirements:
 - 1. Processor: Minimum 2.8 GHz Xeon Multi-Core Processor (Intel).
 - 2. RAM: 16 GB minimum.
 - 3. Storage: 500 GB SSD.
 - a. Drives configured RAID 0/1
 - 4. Operating System: Windows Server 2022.
 - 5. Software Environment: .Net 8.0 or greater.
 - 6. Connectivity: Active internet connection for live web map capabilities and remote support.
- C. Additional Requirements:
 - 1. Ensure reliable application hosting with fault tolerance.
 - 2. Enable efficient data processing and user interaction.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install server computers in accordance with manufacturer's recommendations.
- B. Ensure proper ventilation and power supply.
- C. Establish necessary network connections for remote access and monitoring.

3.02 TESTING AND COMMISSIONING

- A. Perform initial system checks for compliance with specified performance criteria.
- B. Verify database connectivity and application functionality.

3.03 COORDINATION FOR FUNCTIONALITY RESTORATION

- A. The Contractor shall work with Transportation Control Systems and SWARCO McCain to ensure the RTMC servers and master switches are configured to Escambia County's original specifications.
- B. The Contractor shall validate successful integration with Escambia County's CMS.
- C. The Contractor shall be responsible for any additional services necessary to restore the original ATMS functionality before final acceptance.

3.04 TRAINING

- A. Provide training for system administrators and operators.

END OF SECTION 40 62 13

SECTION 40 62 16
OPERATOR WORKSTATION COMPUTERS

PART 1 - GENERAL

1.01 SUMMARY

- A. Provide and install operator workstation computers as specified herein, suitable for industrial control environments and adhering to all specified performance, reliability, and compatibility requirements.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00:
 - 1. Refer to "PART 2 – Products" for all Buy America Build America Act (BABA) Requirements

1.03 SUBMITTALS

- A. Provide the following submittals for review and approval:
 - 1. Product Data: Manufacturer's specifications, performance data, and installation requirements.
 - 2. Shop Drawings: Configuration details, dimensional layouts, and mounting requirements.
 - 3. Operation and Maintenance Manual: Include hardware specifications, troubleshooting guidelines, and warranty information.

1.04 QUALITY ASSURANCE

- A. Warranty: Provide a minimum three-year warranty on all components, including parts and labor.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver workstation components in manufacturer's original, unopened packaging.
- B. Store in a secure, climate-controlled environment.
- C. Handle with care to avoid physical damage to components.

1.06 PROJECT CONDITIONS

- A. Ensure compatibility with site power and networking infrastructure before installation.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Approved manufacturers: Dell

2.02 WORKSTATION SPECIFICATIONS

A. Processor:

1. Intel® Core™ i9 14th Gen 14900
2. 36 MB cache, 24 cores, 32 threads, base frequency 2.0 GHz, turbo frequency 5.8 GHz, 65W TDP

B. Operating System:

1. Windows 11 Pro

C. Memory (RAM):

1. 32GB: 2 x 16 GB, DDR5, 4400 MT/s, non-ECC

D. Graphics Card:

1. Nvidia RTX 2000 Ada, 16 GB GDDR6
2. Includes 4 Mini DisplayPorts to DisplayPort adapters

E. Storage:

1. NVMe SSD 512 GB, M.2 2280, Gen 4 PCIe NVMe
2. Provision for additional M.2 SSD

F. Optical Drive:

1. 8x DVD+/-RW/RAM 9.5mm Slimline Optical Disk Drive

G. Power Supply:

1. 500W (80 Plus Platinum) PSU, DAO

H. Wireless Connectivity:

1. Intel® Wi-Fi 6E AX211, 2x2, 802.11ax
2. Bluetooth® wireless card with external antenna

I. Input Devices:

1. Wireless keyboard and mouse

J. Camera:

1. WebCam with support for 2K QHD (24, 30 fps), Full HD (24, 30 fps), and HD (24, 30, 60 fps)

K. Monitors:

1. Four (4) 27" UHD monitors per workstation.
2. Compatible desk mounted monitor mounts according to operator console manufacturer recommendation.
3. Integrated USB hub.

2.03 ACCESSORIES

- A. Required cables and adapters for full connectivity.
- B. Power cables matching site requirements.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Mount monitors and position workstation components per shop drawings.
- B. Connect power and ensure compatibility with the site electrical infrastructure.
- C. Configure wireless connectivity and ensure stable performance.
- D. Verify display alignment and calibration across all monitors.
- E. Hardwire ethernet network connection to workstations.
- F. Install workstation computers inside the video wall cabinets with full USB and display connectivity to the operator console monitors.

3.02 TESTING AND COMMISSIONING

- A. Test all components for proper functionality:
 1. Booting sequence and performance benchmarking.
 2. Display configuration and graphics rendering.
 3. Network connectivity, including Wi-Fi and Bluetooth.
 4. Peripheral operations, including keyboard, mouse, and camera.
- B. Correct any deficiencies before final acceptance.

3.03 DOCUMENTATION AND TRAINING

- A. Provide end-user training on workstation operation and maintenance.

- B. Submit operation and maintenance manuals and warranty documents.

END OF SECTION 40 62 16

SECTION 40 62 26
LAPTOP COMPUTERS

PART 1 - GENERAL

1.01 SUMMARY

- A. This section specifies the procurement, configuration, and installation requirements for 30 laptop computers intended for operational use in industrial and commercial environments.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00:
 - 1. Refer to "PART 2 – Products" for all Buy America Build America Act (BABA) Requirements

1.03 SUBMITTALS

- A. Product data: Submit manufacturer's technical data sheets for approval.
- B. Warranty documentation: Provide warranty details for all components.
- C. Sample unit: Provide one laptop for evaluation if requested.

1.04 QUALITY ASSURANCE

- A. Laptops shall comply with all applicable safety, environmental, and performance standards.
- B. All components must be new and free of defects.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver laptops in original manufacturer packaging.
- B. Store in climate-controlled conditions, avoiding exposure to moisture or extreme temperatures.

PART 2 - PRODUCTS

2.01 APPROVED MANUFACTURERS

- A. Manufacturers meeting the specifications outlined below are acceptable upon approval.

2.02 LAPTOP SPECIFICATIONS

- A. Processor
 - 1. 13th Gen Intel® Core™ i7-1355U
 - a. 12 MB cache

- b. 10 cores, 12 threads
 - c. Up to 5.0 GHz Turbo
- B. Operating System
 - 1. Windows 11 Pro
- C. Graphics
 - 1. Intel® Integrated Iris® Xe or UHD Graphics, as appropriate for the specified processor.
- D. Display
 - 1. 15.6" FHD (1920x1080) Touchscreen
 - 2. Anti-glare, IPS technology
 - 3. 250 nits brightness
 - 4. FHD IR Camera with WLAN support
- E. Memory
 - 1. 16 GB DDR5 RAM: 2 x 8 GB configuration
 - 2. 5600 MT/s (5200 MT/s effective with 13th Gen Intel® Core™ processors)
- F. Storage
 - 1. 512GB M.2 2230 QLC PCIe Gen 4 NVMe SSD
- G. Connectivity
 - 1. Ports:
 - a. 1 USB4® (20 Gbps) with Power
 - b. 2 USB 3.2 Gen 1 (5 Gbps) ports
 - c. 1 USB 3.2 Gen 1 (5 Gbps) port with additional capabilities
 - d. 1 HDMI 1.4 port
 - e. 1 RJ45 (1 Gbps) Ethernet port
 - f. 1 universal audio port
 - g. 1 power-adaptor port
 - 2. Wireless:

- a. Intel Wi-Fi 6E AX211 (2x2, 802.11ax)
- b. Bluetooth Wireless Card

H. Power

- 1. Primary Battery: 3-cell, 54Wh
- 2. USB-C Docking Station compatibility.

2.03 ACCESSORIES

- A. Two (2) 27" UHD monitors with adjustable stands.
- B. UCB-C Docking Station

PART 3 - EXECUTION

3.01 PREPARATION

- A. Verify compatibility of laptops with existing docking stations and peripherals.
- B. Ensure power outlets and data ports are available and functional at installation locations.

3.02 INSTALLATION

- A. Install and configure laptops per manufacturer's instructions.
- B. Update operating system and drivers to the latest versions.
- C. Conduct initial system testing to ensure all hardware and software components are functional.

3.03 TESTING AND VERIFICATION

- A. Perform system diagnostics to confirm CPU, memory, storage, and connectivity performance.
- B. Test display for brightness, touchscreen functionality, and camera clarity.
- C. Verify wireless and Ethernet connectivity.

3.04 WARRANTY AND SUPPORT

- A. Laptops shall include a minimum 3-year warranty.
- B. Provide technical support contact information for post-installation assistance.

END OF SECTION 40 62 26

SECTION 40 66 33
METALLIC AND FIBER-OPTIC COMMUNICATION CABLING AND CONNECTORS

PART 1 - GENERAL

1.01 SUMMARY

- A. Provide and install fiber-optic communication cabling, connectors, and hardware as specified by Florida Department of Transportation, FY2025-26 Standard Specifications for Road and Bridge Construction, Section 633 Communication Cable.

1.02 RELATED WORK

- A. SUMMARY OF WORK: Section 01 11 00:
 - 1. Refer to "PART 2 – Products" for all Buy America Build America Act (BABA) Requirements

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Must meet FDOT FY2025-26 Standard Specifications for Road and Bridge Construction, Section 633 Communication Cable.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install according to plans and FDOT FY2025-26 Standard Specifications for Road and Bridge Construction, Section 633 Communication Cable.

END OF SECTION 40 66 33

SECTION 40 67 13
COMPUTER EQUIPMENT RACKS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. 45U SmartRack Standard-Depth Server Rack Enclosure Cabinets with doors and side panels.

1.02 RELATED WORK

A. SUMMARY OF WORK: Section 01 11 00:

1. Refer to "PART 2 – Products" for all Buy America Build America Act (BABA) Requirements

B. Division 26 – Electrical

1.03 SUBMITTALS

A. Product Data: Provide manufacturer's technical data and installation instructions.

B. Shop Drawings: Include dimensions, layouts, and clearances.

C. Certification: Provide certificates of compliance with UL, RoHS, and CE standards.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Deliver products fully assembled and ready for installation.

B. Store products in a dry location, protected from dust and damage.

C. Handle using manufacturer-recommended procedures.

1.05 WARRANTY

A. Provide a 5-year limited manufacturer's warranty.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Tripp Lite, an Eaton brand.

B. Model: SR45UB 45U SmartRack Standard-Depth Server Rack Enclosure.

2.02 EQUIPMENT

A. Dimensions and Weight Capacity:

1. Height: 83.75 in (212.725 cm)
 2. Width: 23.63 in (60.02 cm)
 3. Depth: 43.00 in (109.22 cm)
 4. Stationary Weight Capacity: 3500 lbs (1588 kg)
 5. Rolling Weight Capacity: 2250 lbs (1020.6 kg)
- B. Construction Features:
1. Steel frame with a textured black powder coat finish.
 2. Ventilated front and rear doors with 65% open perforation.
 3. Locking, removable, and reversible front and rear doors.
 4. Locking, removable side panels, keyed alike with doors.
- C. Additional Features:
1. Pre-installed casters and leveling feet.
 2. Adjustable vertical rails with unthreaded square holes.
 3. Toolless accessory mounting rails with slots for PDUs and cable managers.
 4. Integrated latching tabs for secure row configurations.
 5. Built-in grounding points on front and rear doors.
- D. Accessories:
1. 50 M6 screws, 50 M6 cage nuts, and 50 M6 washers.
 2. 2 keys for door and side panel locks.
 3. (2) Eaton EPBZ96 Rack PDUs, 0U, L5-20P input, 1.92 kW max, 110-125V, 16A, 6 ft cord, Single-phase, Outlets: (24) 5-20R, installed per manufacturer recommendations per enclosure.
 4. Blanking panels for all unused rack units to ensure optimal airflow for cooling.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install the computer equipment racks per manufacturer's instructions.
- B. Ensure proper alignment and level the racks using the adjustable feet.

C. Provide grounding as required, connecting to earth ground.

3.02 ADJUSTMENTS AND CLEANING

A. Adjust doors and panels for proper operation and secure locking.

B. Remove all packaging and debris from the site.

3.03 PROTECTION

A. Protect racks from damage until installation is complete.

END OF SECTION 40 67 13